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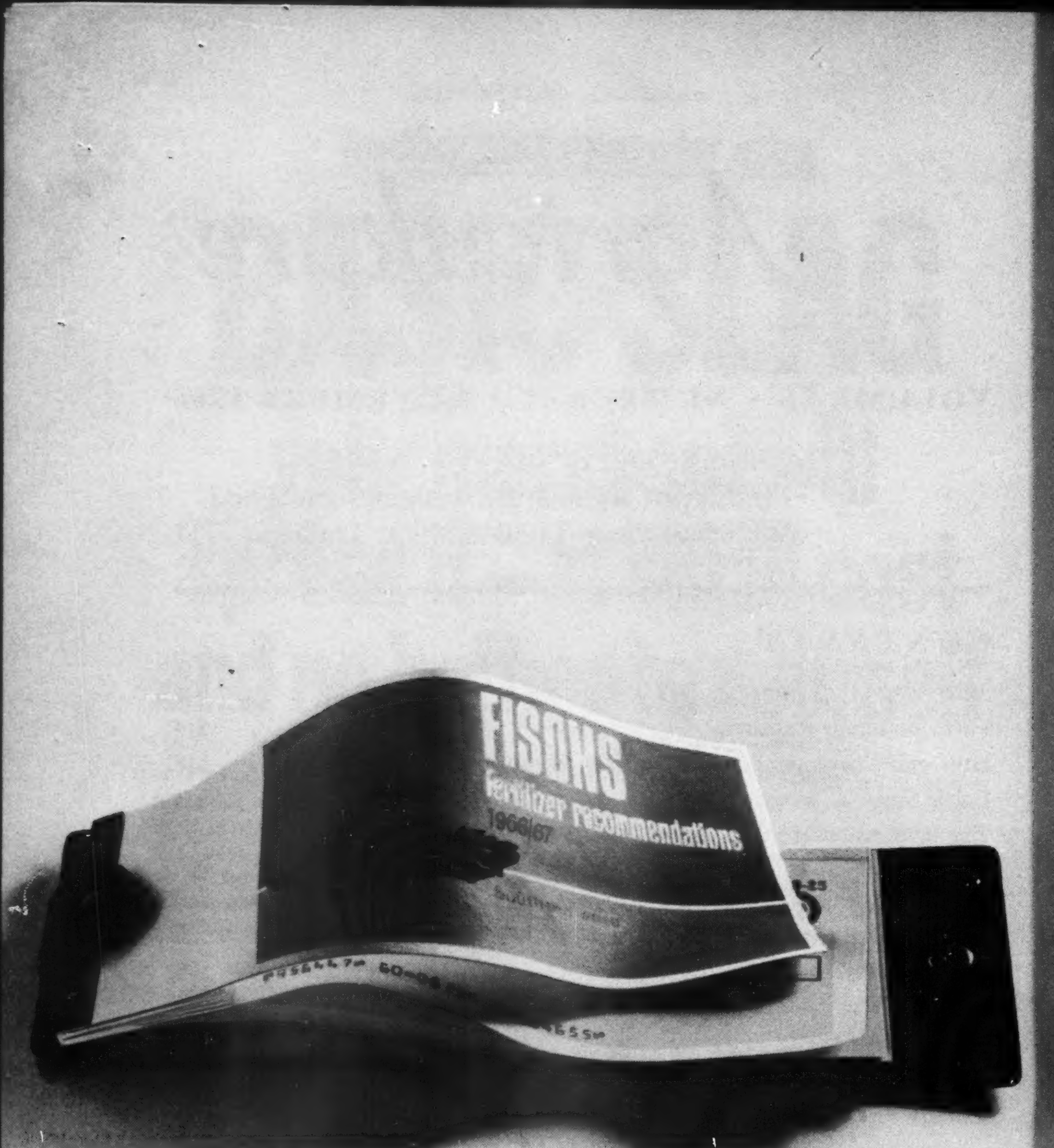
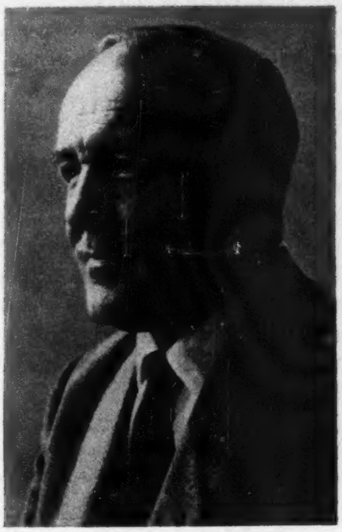
CONTENTS


FISONS
fertilizer recommendations
1966/67

AGRICULTURE NOVEMBER 1966

Ten Years of Farm Safety



G. S. Wilson

IN July, 1956, the Agriculture (Safety, Health and Welfare Provisions) Act became law. This event marked the first serious attempt to deal with the rising tide of farm accidents. There had been two earlier Acts towards the end of the last century in connection with threshing machines and chaff cutters, and in 1952 the Agriculture (Poisonous Substances) Act was passed to deal specifically with the safe use of pesticide products.

The legislation

The Safety Health and Welfare Act came into being largely because of the great advance in mechanization on our farms, bringing with it dangers that had not previously existed. Farms were becoming more like factories and at one stage the Trades Union Congress suggested that the Factories Act should be extended to include agriculture. The Act gave powers to the agricultural Ministers to make regulations for protecting workers employed in agriculture against risks of bodily injury or injury to health arising from their employment and also for the avoidance of accidents to children on farms. Provision was made for the appointment of inspectors to enforce regulations.

In the middle of September, 1956, the first three inspectors to be appointed met to consider what needed to be done and how farm accidents could be prevented. This team consisted of a chief safety inspector and two deputies and the material available to them consisted of a copy of the Act and the

information on farm accidents which had been collected over the previous year or so. With so little information, it was quite impossible to attempt to frame one comprehensive set of regulations. At the same time it was essential to collect as much information on the causes of accidents as quickly as possible. Even at that early stage it was quite evident that only some accidents could be prevented by legislation and a great many would have to be dealt with by education, advice and publicity.

Safety officers

When regulations are made placing legal obligations on employers and workers it is essential to have inspectors to see that they are observed. This means the recruitment and training of a competent corps of safety officers, in itself a considerable task. Fortunately, in those early days we had the benefit of the experience of two senior members of the Factory Inspectorate who were loaned to the Ministry for a few months. In 1957 eight regional safety inspectors were trained and appointed, and arrangements were made with the M.P.N.I. (now the Ministry of Social Security) to notify regional inspectors of any claims for injury benefit arising from work in agriculture (which for this purpose includes horticulture and forestry). This was followed by the appointment and training of 26 Field Officers, Grade I (Safety) stationed at the Ministry's Divisional Offices and 36 Field Officers, Grade II. Selected cases were investigated and reported on, resulting in a steady flow of valuable information on the causes of accidents. A subsequent reorganization of the Ministry's field officer structure has resulted in over 400 Grade II officers being trained and appointed to accident prevention work in addition to other duties. This massive task of training took four years to complete.

Wide range of accidents

Because of the extremely wide range of jobs done by a farmer or farm worker, the risks to which he is exposed are infinitely varied. They include such things as the use of field and barn machinery, the handling of animals, gunshot, strains and back injuries, falls of every kind, cuts inflicted by hand tools, electrocution and some diseases common to those who live and work on the land.

It has been possible to keep accurate statistics of fatal accidents since 1957 because the Act of 1956 requires that a coroner holding an inquest on the body of a person whose death may have been caused by an accident in the course of agricultural operations shall adjourn the inquest unless a Ministry inspector is present. This is a valuable aid to maintaining accurate statistics and enables inspectors to learn at first hand, from the evidence of witnesses, about the events that led to the death of the victim. Each year since 1957 the overturning tractor has been responsible for roughly a third of the fatal accidents (see table p.511).

Happily the trend has been downwards since the peak year of 1961, with a corresponding decline in non-fatal accidents. Nevertheless, it is a mistake to measure the effect of accident prevention measures by relating them to numbers of accidents. If only we knew how many lives had been saved and how many crippling injuries had been avoided because of guards and safety devices, what a story could be told! And what a human tribute it would be to the safety work of the last ten years.

Fatal accidents in agriculture (1957–65)
All causes and overturning tractors

	England and Wales		*Great Britain*	
	Total all causes	*Overturning tractors*	*Total all causes*	*Overturning tractors*
1957	112	34	131	36
1958	109	33	137	40
1959	123	32	151	40
1960	109	26	125	31
1961	141	47	165	56
1962	127	47	156	50
1963	97	25	118	38
1964	106	31	131	38
1965	93	36	118	45

The regulations

At intervals over the past decade ten sets of safety regulations have been made, which may briefly be described as follows:

First aid. Regulations require that a first aid box with specified contents should be kept on every holding where workers are employed.

Ladders. Ladders must be soundly constructed and properly maintained.

Power-take-off. The p.t.o., p.t.o. shaft, and couplings have to be guarded.

Children. Children under 13 are not permitted to drive or ride on tractors and other specified implements and machines.

Circular saws. Saws must have guards above and below the table. There are minimum ages for operators.

Workplaces. Stairways, fixed ladders and openings in farm buildings have to be fenced or guarded to protect workers against falling.

Stationary machinery. Machinery must be so protected or situated that it is safe for a worker to operate.

Heavy weights. No farm worker must be required to lift or carry unaided a sack and its contents exceeding 180 lb.

Threshers and balers. Dangerous moving parts have to be guarded and precautions taken to prevent falling from the deck of a thresher.

Field machinery. These regulations require a wide range of field machinery to be guarded and fitted with safety devices. They also place responsibilities on manufacturers and dealers, who are not allowed to sell a new field machine for use in agriculture unless it complies with the regulations.

In addition the Act itself requires the provision of suitable and sufficient washing and sanitary facilities and provides that workers under 18 shall not be made to lift, carry or move heavy loads.

The observance of these regulations is preventing accidents, but so much depends on the proper training and good safety sense of farmers and workers. Nevertheless, in the view of the author

no accident prevention campaign can succeed unless it is founded on sensible regulations enforced by a team of trained inspectors armed with the necessary powers of entry and inspection.

The greatest single cause of fatal farm accidents

Overturning tractors

The greatest single cause of fatal farm accidents is the tractor which overturns and crushes the driver to death. Every year this kind of fatality accounts for between 30 and 40 per cent of the total. In 1965, for instance, there were 45 tractor-overturning deaths out of a total of 118 fatal accidents, and up to the middle of August this year we have recorded 30 overturning deaths out of a total of 75. No other kind of farm accident has received so much attention: leaflets have been widely circulated, films have been made and shown to thousands of farming audiences, the subject has been featured time after time on television and sound radio, and safe tractor driving has been emphasized at meetings throughout the country and at agricultural shows. But drivers continue to overturn tractors and kill themselves. Most farm tractors weigh somewhere in the region of two tons, and even when other people are present on the scene, little can be done to rescue the victim until heavy lifting equipment arrives. It has proved virtually impossible to prevent tractors overturning, so the only remedy is to protect the driver from being crushed to death when it happens. Proposals for regulations which will require the compulsory fitting of safety cabs or frames have been prepared and consultations have already taken place with interested organizations. Regulations of this kind in other countries have proved to be effective and have saved many lives.

New pattern of accidents

In some respects the many causes of farm accidents show little change over the years, but in other ways new methods of husbandry and use of mechanical power have altered the pattern. The growth of artificial insemination has meant that far fewer bulls are kept on farms, resulting in a considerable reduction in bull accidents. On the other hand, the increasing use of electricity as a means of power and heat is sending up the number of deaths by electrocution. This is becoming a serious problem. The trouble

with electricity is that the danger is seldom apparent, unlike the blade of a circular saw which can be seen to be dangerous. In addition, there are far too many people who are prepared to extend an existing installation or carry out repairs without having the required knowledge of electricity to do the job safely. Electrical engineering is a skilled occupation and only a qualified electrician should carry out wiring and see to regular maintenance.

Increased publicity

Although regulations serve to prevent some accidents, a high proportion are caused by ignorance, carelessness, human error and sometimes sheer folly. These must be subjects for education, advice and publicity. Farm safety films have proved to be an excellent and popular medium. Eleven have so far been made and shown all over the country to farming audiences. The national and provincial Press, as well as the farming weeklies, are constantly putting out safety advice, whilst the B.B.C. and independent television companies make frequent use of short farm safety films. The Royal Society for the Prevention of Accidents employs a full-time farm safety officer and is very active in the education and publicity field.

Conclusion

Ten years ago there were numerous accidents on our farms but there was no organized attempt to prevent them; they were regarded as 'just one of those things'. All that has changed. One of the most satisfactory aspects has been the readiness with which the agricultural industry and the agricultural machinery industry has accepted the need for accident prevention, although this was something new for both of them. The future will bring new problems as new methods of cultivation and husbandry come into being and ever larger and more powerful machinery comes into use, but farm safety is now established as an essential of modern farming techniques. No task is more important than that of accident prevention because the vital aim is to save human life and prevent human suffering.

This article has been contributed by **G. S. Wilson**, the Ministry's Chief Safety Inspector, who, before he joined the Ministry, had 10 years' practical farming in partnership with his father.

Farm Buildings Research

A general review of the organization of research affecting farm buildings in Britain

Nigel Harvey

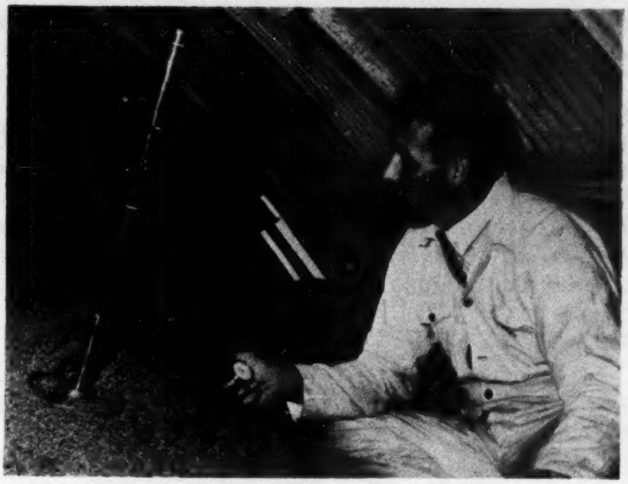
THERE is no very simple way of summarizing the organization in this country of what is commonly called farm buildings research but is more accurately described as research affecting farm buildings. For the subject, which covers the design, construction, economics and operation of a mass of different types of buildings, is large and fragmented; the problems which arise and the methods of investigating them are varied in the extreme; and the research is undertaken at a wide variety of centres. So it is only possible to give a very general guide to the places and types of project involved. But even this is sufficient to show that considerable resources are being applied to the complex of problems which face those who plan, construct and use farm buildings.

The Agricultural Research Council

The primary official body concerned with agricultural research, including farm buildings research, is the Agricultural Research Council which supervises a chain of centres that between them cover most branches of agricultural science. Farm buildings work is undertaken at the centre where the subject is most appropriate. Sometimes the functions of these centres are obvious from their names. Thus, the National Institute for Research in Dairying includes research into milk production buildings among its investigations. Sometimes, however, the titles are less revealing. The Pest Infestation Laboratory, for example, is concerned with grain storage, and Ditton Laboratory with potato storage. At the present time a dozen of the Council's institutes are engaged on farm buildings problems, the work thus undertaken ranging from fundamental research into the environmental needs of livestock and the behaviour of crops in storage to investigations into such immediately practical farming problems as those which arise in the planning of cubicle systems and potato stores. The Council has also sponsored experimental buildings on commercial farms under the Experimental Farm Buildings Scheme, which has been administered since the beginning of the year through the Farm Buildings Department of the National Institute of Agricultural Engineering.

Other research organizations

Other institutes whose work affects farm buildings are the Building Research Station, the Royal Veterinary College and the Water Pollution



Measuring the rate of airflow during cooling of bulk barley

Research Laboratory. These are concerned respectively with materials and structural problems for the entire building industry, with the hygienic and environmental needs of livestock and with the disposal of effluents. A good deal of relevant work, too, is undertaken by the agricultural or economics departments of universities and colleges, while the three Scottish agricultural colleges have recently combined to establish a Farm Buildings Investigation Unit responsible for the co-ordination of farm buildings investigational work in Scotland. Further, the Experimental Husbandry Farms of the Ministry of Agriculture, Fisheries and Food include work affecting farm buildings in their programmes, and from time to time the Agricultural Land Service, the National Agricultural Advisory Service, and the Veterinary Investigation Centres undertake surveys or studies of particular problems.

In addition, certain supply, marketing or development bodies, such as the Electricity Council, the Potato Marketing Board and the Pig Industry Development Authority, relevant trade development bodies, such as the Cement and Concrete Association and the Timber Research and Development Association, and some of the larger firms serving agriculture carry out or sponsor projects affecting the design or construction of farm buildings.

Scope and volume of research

In all, work affecting farm buildings is now in hand at more than fifty British centres which between them carry some two hundred projects on their books. So it is clearly impossible even to summarize the main types of problems under investigation. But, as you would expect, many of them arise from the problems which now face British farming, notably the intensification of agriculture, particularly livestock enterprises, in a small and crowded island where costs of production are steadily increasing.

There is, for example, the interest in animal behaviour in relation to housing systems, in the housing of sheep, traditionally the most open-air of all farm animals, in the utilization and disposal of manure and other farm wastes, and in methods of conserving and feeding grass. In a predominantly livestock country, the emphasis naturally falls on the housing of animals. But the arable farmer need not feel neglected. Ten centres are

currently concerned with problems of grain storage and twelve with problems of potato storage.

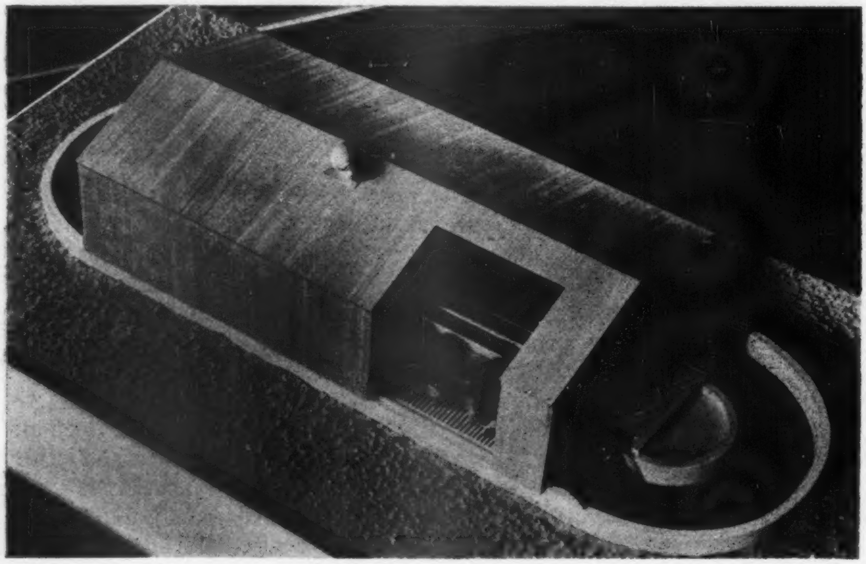
So far, we have concerned ourselves solely with British work. But, of course, a great deal of overseas work applies directly or indirectly to British problems, just as some of the work in this country will, we hope, interest our colleagues elsewhere. Publications issued in Britain or in any country where climate and economic conditions make the evidence relevant to farm buildings problems in Britain are summarized in the Agricultural Research Council's *Bibliography of Farm Buildings Research*, which is now in its seventh year of publication.

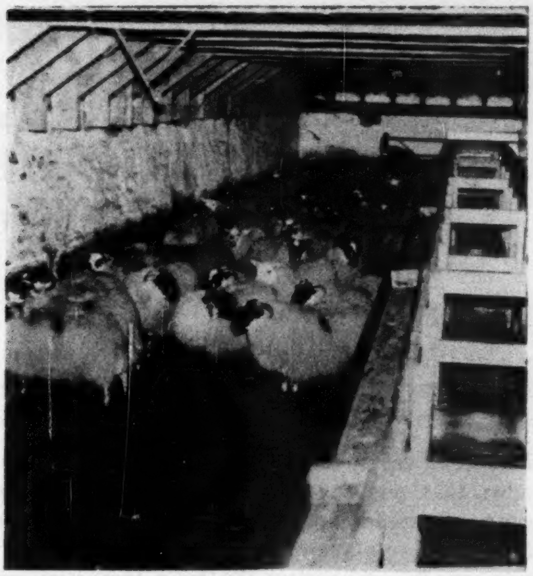
Some facts and figures

Statistics on research publications are necessarily crude in the extreme for they can take no account of the scope or quality of the work. But a few figures may help to put matters into perspective.

Firstly, the amount of research material of interest to British designers is considerable. To take at random three subjects of current interest, there are on record about fifty research papers on the cubicle system, nearly a hundred on the airtight storage of grain and over a hundred and fifty on the disposal of farm wastes. Again, on a more specialized point, it is only recently that the influence of gases arising from the slurry below slatted floors on the atmosphere in the house have been appreciated, yet already more than twenty reports on this problem have appeared. Secondly, the number of papers published is increasing year by year. It has, indeed, more than trebled in the last decade and shows no signs of flagging. Thirdly, this country is making a substantial contribution to the international fund of farm buildings knowledge as well as receiving substantial benefits from it. Of the 2,300 papers which appeared in 1962–5, some 40 per cent came from North America, 30 per cent from Britain and 30 per cent from some fifteen other countries, mostly those in western Europe.

Model of fully slatted floored feeding piggery with oxidation ditch sludge disposal





Trials of the wintering of hill ewe hoggs in a slatted floor building

Fortunately for farm buildings advisers, there is little difficulty in obtaining the information thus published, for most of these papers are readily available to anyone in this country who cares to avail himself of the library services. But it is worth emphasizing that, as a rule, the research workers who prepared them have no responsibility for the dissemination or application of the evidence and recommendations they have produced. Their responsibilities end when their completed projects are reported in the scientific or technical press or in the publications of their centres. The application of their findings to particular cases, to particular farms, is the business of those who advise and inform the farmer; the conclusions of the research workers reach him in a variety of ways, through the official advisory services, through private consultants and agricultural firms, through the Farm Buildings Centre and the agricultural press. There is no lack of intermediaries to carry the findings of the research station to the farm.

Practical value

All this, however, leaves one question unanswered. What, you may ask, is the practical value to the farmer of all this research? Well, it would not be difficult to quote a mass of instances in which research findings have helped to improve design, make possible new developments, increase efficiency and lower production costs. But this would mean a long answer. The short answer is simple and obvious. The practical value of farm buildings research, as of all agricultural research, depends on the use that the farmer and his advisers make of it.

This is the opening article of a series, which will be published in *Agriculture* from time to time, about interesting pieces of research affecting farm buildings.

Nigel Harvey, M.A., Q.A.L.A.S., spent twelve years as a Farm Buildings Advisory Officer of the Ministry and eight as a member of the Agricultural Research Council's Farm Buildings Unit. He is now on the Council's staff in London where he edits the *Bibliography of Farm Buildings Research*.

How many cows per cowman?

A. E. Hirons A. J. Quick

In recent years, there have been many inspired guesses at the number of cows that one cowman can manage. The inspiration stems from current economic trends and pressures, the movement of labour to other industries and the development of improved mechanical equipment. The purpose of this article is to outline the main factors which influence this number and to show which of them have the greatest effect. The relative information and data have been collected from commercial farms. Only recently has any serious effort been made to collect information by a controlled investigation.

According to the 1965 Milk Marketing Board Survey[1] the average number of cows milked per worker is 19 only. How is it, then, that in an increasing number of herds one man can not only milk, but completely manage 60–80 cows or more? The cynics will suggest that in these cases the job is not being done properly, but it is only where additional numbers of cows are imposed upon a system incapable of carrying them that quality suffers. The evidence shows that, for example, between the 30– and 50–cow herds milk yields rise by 1½ per cent whilst labour hours per cow fall by 20 per cent.[2] It is true that in many cases it is only the milking that is being done by one man, whilst additional labour assists with the chore jobs. By one man we mean that a dairy farmer employs one man to do all the normal daily routine tasks associated with the dairy herd.

Where are the savings?

Usually, the cowman's working day consists of three periods of three hours, giving approximately 60 available man-hours per week. Existing data[3] suggest that two man-hours per cow per week are required in an efficiently-run cowshed, thus limiting to 30 the number of cows one man can handle, whereas in an average yard-and-parlour one man handles 40 cows at 1½ man-hours per cow per week. The inference is obvious: where the system is designed to reduce the operator's work-load to 1 or ¾ man-hour per cow per week he can manage 60–80 cows without difficulty. Yard-and-parlour systems offer the better potential for work simplification by the elimination

1. *Structure of Dairy Farming in England and Wales 1963–64.*
2. Coward, N. Paper given at Power Farming Conference, 1965.
3. Cambridge University Farm Economics Report No. 58.

or reduction of materials handling by improved methods and by mechanization.

TABLE 1

Effect of the work-load on the number of cows one man can handle

Cowshed		Yard-and-parlour	
Man-hours per cow per week	No. of cows	Man-hours per cow per week	No. of cows
2	30	$1\frac{1}{2}$	40
$1\frac{1}{2}$	40	1	60
		$\frac{3}{4}$	80

No doubt because milking occupies more of the cowman's time than any other single task it is often believed that the greatest labour savings will occur at milking time following a change of system from cowshed to yard-and-parlour (see Table 2).

TABLE 2

*Proportions of the cowman's time spent at various tasks (U.K. and U.S.A.)**

Task	U.K.	U.S.A.
	%	%
Milking	40	50
Dairy work	15	10
Feeding	20	5
Cleaning and littering	20	15
Management	5	20
Total	100	100

*Comparing similar systems.

In fact, the greatest savings will come from the chore jobs (feeding, cleaning and littering), even when these improvements are related to the proportionate time that these tasks occupy within the daily routine (see Table 3).

TABLE 3

Percentage improvement in labour usage to be expected in a change from cowshed to yard-and-parlour

Task	Task proportion (from Table 2)	Overall improvement	Actual improvement
	%	%	%
Milking	40	17	6·8
Feeding	20	43	8·6
Cleaning and littering	20	30	6·0

A typical case

The same reasoning can be applied to changes which are planned within a system. A typical case occurred in Somerset where, following a farm business analysis, an increase in herd size was recommended from 60 cows, managed by two men with part-time help, to 120 cows to be managed by two men only. The system was a mixture of cowsheds and loose-housing, with some forage being cut and carted and some self-fed. The cows were milked in batches through a part of another cowshed. Before making any

recommendations, a check was made on the existing work-load and the results compared with existing data (see Table 4).

TABLE 4

Work-load measurement compared with premium figures for same system*

(Man-min per cow per week)

Task	Recorded	Premium*
Milking	39·7	40·0
Dairy work	7·5	12·0
Cleaning	26·1	20·5
Littering	4·8	
Feeding	19·5	14·0
Miscellaneous	4·6	16·0
Total	102·2	102·5

*Top 25% of average.

As we have seen, if two men were to handle 120 cows their work-load for a 60-hour week would have to be no more than one hour per cow per week each. Recommendations included a full loose-housing system, self-feed silage, and a simple system of manure disposal using existing slopes and levels to scrape slurry to a winter storage compound. Two bails, used for milking in the fields in summertime, were housed inside part of one of the cowsheds, the remainder of the shed being used as a covered collection yard. A re-check was made when the new system had settled down and the results were compared with existing data for a yard-and-parlour system (see Table 5).

TABLE 5

Work-load measurement for revised system compared with premium figures*

(man-min per cow per week)

Task	Recorded	Premium*
Milking	34·3	32·0
Dairy work	9·6	12·0
Cleaning	8·3	12·0
Littering	2·3	
Feeding	2·4	11·0
Miscellaneous	0·4	10·0
Total	57·3	77·0

*Top 25% of average.

These figures show that virtually all the improvement came from the chore jobs of feeding, cleaning and littering. The reorganization also reduced the time taken for the miscellaneous tasks but little improvement came from the change in milking systems. This was because direct-to-can milking was preferred for summer milking in the fields, but considerable improvements were made later by installing pipeline milking with the bails in a fixed position. This change improved milking performance and the time saved was devoted to cow management tasks.

Choosing a system

The controlled investigation to which reference has been made is in progress at the National Institute for Research in Dairying where a system

has been installed so that one man can manage 80 cows or more. Daily cleaning and littering have been almost eliminated, feeding is automated and milking is done through a five-unit, ten-stall herringbone parlour. Ample time is available for cow management and it is clear from the results of a work measurement study recently completed that the operator could handle 120 cows without difficulty (see Table 6).

TABLE 6

Work-load measurement for mechanized system at N.I.R.D.

(1 man to 80 cows)

Task	Man-min per cow per week
Preparation for milking	4·20
Milking	15·75
Dairy work	3·50
Cleaning and littering	1·05
Feeding	0·00
Total	24·50
Time for management and miscellaneous tasks	20·50
Total	45·00

Clearly, the number of cows that one man can handle depends upon the system chosen. Emergencies which occur can be dealt with by telephoning the farmer and/or the vet, but simple and fool-proof aids to day-to-day cow management are essential, e.g., one-man operated diversion arrangements for cows requiring attention after milking, and an efficient system of cow record keeping. It is also clear that if a man is to manage the maximum number of cows, all available evidence suggests that he requires a yard-and-parlour system within which to operate. This provides him with opportunities to simplify and mechanize tasks as cow numbers increase in order to extend his management, time and skills to care for the extra animals.

Feeding

The man-handling of bulky fodder, especially silage, must be eliminated. Self-feeding at the face of the silage clamp is the simplest means of achieving this end. Mechanical feeders are more expensive but have the advantage that the volume of fodder fed can be controlled and some types of feeder can be used for a variety of materials: the use of self-unloading trailers is shown in one American report[4] to be a cheaper form of mechanization for the larger herd. The 'easy-feed' system, where the fodder is dropped from the store to feed bunkers placed alongside, is a method which has the advantages of control of volume and variety of material. Because handling is involved, however, the system is more suitable as a means of supplementary feeding of relatively lightweight material than as the sole method where a herdsman is being called upon to manage the maximum number of cows.

4. Quick, A. J. *Developments in American Dairying*. Kellogg Report, 1964.

Cleaning and littering

The routine cleaning of manure on un-bedded concrete areas can be eliminated by covering them with slats or perforated metal so that the manure falls to a pit below. An alternative is the tractor-mounted scraper, which is an efficient tool for cleaning cow manure provided the concrete areas are arranged in the form of strips with access at either end, and the disposal point is near one or other of these ends. Access to disposal may be by ramp elevating to about 5 feet or by mechanical elevator from a sump. The daily littering of straw beds can be eliminated by substituting cow cubicles, where littering is confined to a sprinkling of sawdust once or twice weekly.

Milking and dairy work

The provision of expensive new milking arrangements is frequently the only alteration made as cow numbers per man increase, but as has been shown the savings achieved are likely to be small compared with equivalent investment in other areas. The principle requirement during milking is awareness and time—fatigue sets in early in any milking parlour if other work has claimed most of the herdsman's mental and physical energy. The parlour should provide comfortable working conditions and facilities to eliminate or simplify repetitive tasks. The batch movement of cows, as in the herringbone, eliminates a good deal of the stall-changing operation; the use of warm-water sprays and paper towels for udder washing eliminates the handling and replenishment of pails. The development of an efficient milking technique, coupled with the provision of recorder jars at eye level, can largely eliminate the task of machine stripping which frequently takes 25 per cent of the total milking time.

Virtually the whole of dairy work can now be eliminated due to immense advances in recent years. The cleaning of the milking plant can be accomplished in less than ten minutes and during most of this time the herdsman will be occupied cleaning down the parlour.

Management

All time saved on routine tasks should be used to increase management time as herd size increases; otherwise the extra cows will result in poorer management of the herd as a whole. The skill of the herdsman lies increasingly in his management ability—a factor recognized more widely in America, as is illustrated in Table 2.

The provision of aids to efficient management are essential. Identification of cows by ear or tail tags or by rump mark will eliminate guesswork, coupled with the use of coloured markers or tapes to act as indicators for feeding level or reminders of other action for individual cows. Milk recording is simplified if tape recorders are used or if the number of the cow and yield are written down instead of searching for an individual on a large chart. A breeding record chart can be used to show not only what has happened but, by moving indicators, what should happen today or this week, and what should happen tomorrow and throughout the year. Such a forecast record is invaluable to indicate the periods when the herdsman will require special support. This is especially important where calving is confined to a limited period or season. The parlour should be equipped with facilities

for diversion of individual cows from the herd when they need special attention or treatment, and the diversion pens should ideally lead into a crush suitable for treatments or A.I.

Conclusion

The number of cows a man can manage will be determined first by his own ability and skill and, secondly, by the situation in which he finds himself. If his herd calves throughout the year his potential number is greatest, because there are never many cows needing his special attention at one time. If his herd is autumn-calving, on the other hand, and the winter housing period extends to five or six months, his potential is minimized because his intensive management load at calving and later in getting the whole herd in-calf again coincides with the extra work involved with winter housing chores. It is under such circumstances that the virtual elimination of this work can be fully justified.

The authors of this article, **Miss A. E. Hirons, N.D.D.**, and **A. J. Quick, N.D.D.**, are both Dairy Husbandry Advisers in the South-Western Region of the National Agricultural Advisory Service.

Loose Smut in Wheat and Barley

D. A. Doling

Many diseases occur regularly in this country. Constant vigilance in the use of several control measures has ensured that loose smut is seldom of economic importance. Any relaxation will increase the threat of severely smutted crops.

SMUTTED ears are easily seen in wheat or barley as soon as the crop comes into ear: the mass of brownish-black spores of the fungus *Ustilago nuda* contrasts vividly with the green tissues of neighbouring healthy ears. Every farmer must have seen and wondered why the number of smutted ears fluctuates from year to year and varies within a variety according to the previous history and treatment of a particular seed stock. Although the disease is common in this country, effective control measures have ensured that yields are seldom affected by smut infection. It is rare for the

Partially and completely smutted wheat ears

number of smutted ears appearing in a crop to exceed one in a hundred. Nevertheless, a wheat crop with 17 per cent infection and a barley crop with 20 per cent of smutted ears have occurred in this country and records indicated a yield loss in the barley of about 20 per cent. Given favourable weather, smut can increase rapidly in succeeding generations of seed. A doubling or trebling of the numbers of smutted ears in a seed stock from one season to the next is quite common, whilst a twenty-fold increase occurred in a crop of barley in 1958.

Infection this year—smut next year

The smut spores are dispersed by the wind soon after they emerge from the enclosing flag leaf. Those which alight on neighbouring healthy ears may germinate and penetrate the young, developing grains. These grains are susceptible to infection for only a few days, while the pollen is shed from the anthers. After penetration, the fungus grows into the developing tissues so that at harvest the mycelium of the fungus is situated deep in the embryo and the external appearance of the infected grain is identical to that of healthy grains. When an infected grain is sown and a seedling develops, the loose smut fungus becomes active also. The mycelium grows and colonizes the cells of the young shoot including the growing point at the very top of the shoot. For a period the fungus remains dormant whilst the shoot develops its leaves, but eventually, when the ear is being formed, the mycelium renews its activity and invades the cells of the developing ear so that by the time the ear emerges almost all of the tissues have been replaced by masses of dark spores.

A plant growing from an infected grain of barley will have each ear smutted. Occasionally a barley ear will be smutted towards its base and have normal florets near the apex, but this is rare. In wheat, however, it is quite common to find partially-smutted ears or a mixture of completely smutted

and healthy ears on one plant. Under certain conditions some wheat varieties may produce only healthy ears from infected grains. The proportion of smutted ears is not, therefore, always the same as the proportion of infected wheat grains and an examination of the embryos is not a reliable guide to the healthiness of the resultant crop. The opposite is true of barley. There is a close similarity between the two results, and an embryo examination of barley gives a reliable guide to the amount of loose smut likely to occur in the field. Such an examination can be made by the Official Seed Testing Station, Huntingdon Road, Cambridge, for a fee of 30*s*.

Favoured by a wet June

The degree of infection seen the following year is mainly determined by weather conditions during flowering. Warm, humid conditions with showers or light rain in June encourage infection of the florets, whereas hot, dry weather reduces the number of successful infections by the loose smut spores. Other environmental factors can also have some effect at the seedling stage on the proportion of smutted ears seen. These are not yet fully understood but their effect is relatively small compared with the influence of the weather at flowering. They may act directly; for instance, low temperature prevents the development of the loose smut mycelium in some wheat varieties so that the ears are not colonized. Or they may act indirectly so that, under conditions of intense competition for establishment, smutted seedlings, which tend to be less virile, die out.

Control by seed treatment

Because the loose smut fungus is inside the embryo the commonly used fungicidal seed dressings applied either as dusts or liquids to the outside of the seed are completely ineffective. Since 1888 it has been known that it is possible to soak seed in hot water, thereby killing the mycelium without harming the embryo. But the precise conditions for such a result were very exacting and not reproducible commercially. Recently, experiments at the National Institute of Agricultural Botany have shown that a single bath treatment for which the requirements are less exacting is suitable for commercial use. During the last three or four years, several seed firms have installed suitable equipment, and large quantities of cereal seed are now hot water treated. The recommended treatments are a single soaking for 2½ hours at 109 degrees F for barley or 115 degrees F for wheat. At the end of the soaking period the grain must be dried immediately as it has a moisture content of about 35 per cent. It is this factor which controls the rate at which seed can be treated and also makes it an impracticable proposition for the farmer.

The chemical treatment of seed, at least in barley, for the control of loose smut is a distinct possibility. A small test at Cambridge, reported in the N.I.A.B. Annual Report for 1964, showed that, in Rika, smutted ears were reduced from 236 to 0–8 per plot after treating the seed with a systemic fungicide 'Ustilgon', and more recently Canadian workers have had similar promising results.

Use of healthy seed

Efficient hot water treatment will give seed containing only dead fungus material but which will still germinate well. A good crop, free from smut,

Dark pieces of loose smut mycelium in a wheat embryo

should result. The next best seed, to be sure of having very little smut, would be that subjected to an embryo examination and found to contain less than one infected grain per 1,000 grains. Unfortunately this test is only suitable for the examination of barley varieties.

One of the objectives of the Cereal Field Approval Scheme is to assist in the selection of the least smutted seed stocks. The basic hypothesis is that the healthiest seed is most likely to be produced by the healthiest mother crop: hence fields are inspected in June when the smutted ears can be easily seen and counted. In general terms this conception is true, though weather conditions and the proximity of other diseased crops may have a modifying effect. The normal standard for Field Approval is not more than one smutted ear in 10,000 ears, but lower standards are applicable to susceptible varieties of both wheat and barley. These are not more than 1 in 2,000 in commercial crops and not more than 1 in 5,000 in crops intended for further multiplication. This scheme and these standards are implemented by seed merchants to ensure that reliable seed of the correct variety and as free from loose smut as possible is available to the farmer.

Resistance of wheat and barley

In both wheat and barley there are varieties which exhibit a wide range of susceptibility to this disease. Some are very susceptible whilst others seldom, if ever, contain a smutted ear. The means by which varieties achieve resistance differ in barley and wheat. In barley the loose smut spores are prevented from reaching the surface of the developing grain because the florets remain closed, or very nearly so, during pollination. This mechanical barrier to infection is effective against all forms of loose smut and is, therefore, permanent; resistant varieties remain so despite any changes in the fungus.

In wheat, resistance is physiological. Almost all wheat varieties are susceptible to infection and mycelium can be found in the embryos of both resistant and susceptible varieties. But they differ in the extent to which they allow the fungus to develop, particularly in whether it colonizes the cells of the growing point or not. Wheat loose smut can be divided into a number of

physiological races described by which, and how many, varieties develop spores in place of ears. It follows that the physiological resistance of a variety may be effective against one or many of these races. The fungus, *Ustilago nuda*, can develop new races, just as plant breeding produces new wheat varieties, and they may overcome the resistance of a variety. A resistant variety thus becomes, in practice, a susceptible variety, though its susceptibility is to the new race only. An example of this occurred about 1958. Previously the winter wheat variety Cappelle-Desprez had been tested and found to be resistant to three physiological races of *Ustilago nuda* occurring in this country. But in 1958 many crops of Cappelle-Desprez contained many ears of loose smut. Subsequent testing showed this smut to be a distinct race of the fungus capable of attacking several varieties which were resistant to the other three races. The development and multiplication of a new race of this fungus is slow as it can only complete one spore cycle each year, so that, although such physiological resistance is not permanent, it is likely to be effective for several years.

Reaction of varieties

The reaction to loose smut of many wheat and barley varieties is already known and varieties included in trials at the N.I.A.B. are tested each year. Some varieties prove to be so susceptible that they are considered unsuitable for recommendation. Others find a place on the Recommended List although susceptible to the disease because it is believed that by hot water treatment and subsequent multiplication in isolation from other cereal crops clean stocks can be maintained and distributed commercially. The relative susceptibility of each recommended variety is shown in the wheat and barley Farmers' Leaflets published annually by the N.I.A.B. To be sure of a smut-free crop, choose a resistant variety, or submit the seed for a disease examination, or grow hot-water-treated seed.

This article has been contributed by **D. A. Doling, B.Sc., B.Agric., Ph.D.**, who has been Plant Pathologist in the Trials Branch of the National Institute of Agricultural Botany since 1957. He was previously lecturer in mycology at the Royal Agricultural College.

Intensive Cereal Growing

The first of a series of articles on intensive cereal growing will appear in *Agriculture* shortly.

Accounting Years and Tax Years (Individuals)

G. H. Camamile and E. S. Carter

Individuals and partnerships—preceding year basis

People who are trading either on their own or in partnership, without a limited company, are normally assessed for income tax on their profits on a preceding year basis. The precise meaning of this is that the tax for each income tax year is calculated from the profits of the accounts year which ends in the preceding income tax year.

Income tax year

A small point worth noting is that income tax assessments are made for years ending on 5th April (e.g., 1967–68 runs from 6th April, 1967, to 5th April, 1968, inclusive), whereas the new corporation tax is charged for years ending on 31st March.

Let us consider a hypothetical case of a farmer who has his farm accounts prepared for calendar years.

His profits (as adjusted for tax purposes) are:

Year ending 31st December, 1966	£4,500
Year ending 31st December, 1967	£5,800

His income tax assessments are, quite simply:

For 1967-68

Profits 1966 (i.e., the latest accounts year ending prior to 6th April, 1967)	£4,500

For 1968-69

Profits of accounts year ending 31st December, 1967	£5,800

Starting up and closing down

Obviously, at the beginning of a business, or when it is closed down for any reason, or when there is a change in ownership, the preceding year basis calls for some special rules. These are such that every decision to enter or go out of business, and any changes in ownership, should be made only after taking—and following—good professional advice. The rules themselves will be explained in outline in a subsequent note in this series, and it is sufficient here to say that the results of the first year's trading can provide the basis for more than two years income tax assessments and that when a trade ceases, adjustments can be made by the Inland Revenue to avoid a loss of tax.

Dates of payment

The individual trader (or the partner, through his partnership) has the advantage over the limited company that part of his tax is even further deferred, because he pays his income tax on trading profits in two instalments, on the 1st January *in* the year of assessment, and on the following 1st July. Thus, in the above example, the farmer will be due to pay his 1967–68 income tax (based on his accounts for the calendar year 1966) in two equal parts on 1st January and 1st July, 1968. His 1968–69 tax will be due on 1st January and 1st July, 1969.

(This is the third note in the series 'Tax in Perspective'. A fourth note will appear in next month's issue of *Agriculture*.)

PUBLIC HEALTH AND INTENSIVE LIVESTOCK PRODUCTION

THOSE intending to embark upon a system of keeping livestock on intensive lines without the use of straw or other bedding should, before committing themselves too far, consider very carefully the difficult problem of disposing of the resultant slurry. This can be particularly difficult where only a small acreage of land is available for spreading. Where the holding is near to dwelling-houses this can lead to trouble with local residents and, in extreme cases, to action by the Public Health Authority.

There are so many combinations and permutations of circumstances that in a short note it is impossible to indicate all the steps that may be taken to minimize the risk of nuisance being caused. Advice on methods likely to minimize these difficulties can be obtained from technical officers of the Ministry of Agriculture, Fisheries and Food stationed at Divisional Offices.

Health and Intensive Poultry Production

B. S. Hanson

INTENSIVE methods of agriculture are defined in the Concise Oxford Dictionary as 'methods which serve to increase the production of a given area'. This definition may fairly be applied to modern methods of poultry husbandry. The development of intensive poultry production has been made possible by the introduction of many changes in the type of bird and the methods by which it is fed, housed and managed. Such changes have not always been introduced gradually or rationally and the resultant mistakes have sometimes produced disappointing results and unhealthy stock. But the favourable influence of intensive husbandry on the incidence of poultry disease must not be forgotten. With the decline in the use of extensive methods came the elimination of fowl-sick land, fixed runs, uncontrolled ranging and exposure to unfavourable weather conditions. This resulted in a reduced incidence of diseases such as fowl typhoid, tuberculosis and the acute form of fowl cholera. The introduction of antibiotics and chemotherapeutics made further control of bacterial and parasitic diseases possible. The development of blood testing and the removal of carrier birds has made pullorum disease, which once threatened the future of the industry, a potential rather than an actual danger. The mortality rate in most flocks is lower than it ever was. But this is not enough. The economic loss attributable to disease is now measured in terms of reduced egg production, poor-quality eggs and downgraded carcasses.

Development of disease

Some problems appear to be entirely those of adaptation resulting in nutritional and metabolic disorders. These include the excessive deposition of fat which occurs in some laying birds and in the fatty liver and kidney syndrome. Further examples are found in the conditions characterized by skeletal disorders, such as cage layer paralysis, perosis and allied abnormalities. But infectious diseases are still of much importance. The development of an infectious disease is not a simple process. A specific pathogenic agent may decide the character of a disease, but other factors influence the incubation of infection, the extent to which the disease will develop, its eventual course and the loss incurred. An infectious disease may be regarded as the outcome of the inter-relationships between the pathogen, host and environment. Intensive methods of husbandry influence the whole external

environment of the bird. They can, if unsuccessful, place the bird at a disadvantage and produce conditions which are favourable to the organisms that produce disease, i.e., bacteria, viruses, fungi, worms and protozoan parasites such as coccidia.

It has been shown that chilling and low body temperature not only cause interference with the normal physiological processes, a common source of early mortality in young stock, but can, in birds of all ages, lower resistance and promote the multiplication of viruses. Dust can irritate the respiratory tract and promote infection. Bacteria, particularly *E. coli*, can survive for long periods in dust, particularly if humidity is low. On the other hand warm humid conditions promote the development of coccidial cocysts and worm eggs. Ammonia vapour in the atmosphere can, if present in a high concentration, cause irritation of the respiratory tract and conjunctivitis and affect growth and production. Even at a concentration which may be found frequently in houses during the winter months, it may make birds more susceptible to infection with the virus of Newcastle disease. Overcrowding is not entirely a question of available floor space. If there are not enough food and water containers, or if draughts cause the birds to huddle, leaving areas of floor unused, the effects of overcrowding will be produced.

Spread of infection

Intensive conditions are essentially an increase in the density of the population. This facilitates the spread of any infection. It does so by direct contact from bird to bird, by the spread of nasal discharges, the accumulation of droppings and the contamination of food and water. Indirect spread can occur through droplet infection, the suspension of particles of virus in the atmosphere as an aerosol or on dust. Inefficient ventilation increases the rate of spread, encourages an accumulation of infection and makes the birds more susceptible. Hence the increased incidence of respiratory disease during the winter months when airflow is reduced. When a large group of birds becomes infected with a disease such as infectious bronchitis or Newcastle disease, large amounts of virus are released and the air leaving the houses is heavily contaminated. The virus may not be dispersed before the contaminated air is inspired by susceptible birds in sufficient quantities to infect them. Wind-borne infection is another hazard which has increased with intensive production.

Respiratory diseases rarely occur singly and react with each other to produce a synergistic effect. Broiler septicaemia, which can cause heavy losses in birds around six weeks old, is a good example of this. Although the characteristic lesions of pericarditis, perihepatitis and air sac infection are produced by the coliform infection, it can frequently be shown that there was a previous or underlying infection with mycoplasma (P.P.L.O.) or infectious bronchitis. Similarly, in adult birds, a mild outbreak of mycoplasmosis may be turned into a prolonged respiratory condition with air sac infection by the invasion of bacteria such as *E. coli.* A mycoplasma-infected flock may experience heavy mortality if it becomes infected with infectious bronchitis or Newcastle disease. Large flocks intensively housed are more prone to multiple infections and the economic loss easily becomes insupportable. Although mortality may be low, loss of production and a high percentage of second-quality eggs may necessitate disposal long before the anticipated period of production has elapsed.

Approaches to control

The control of disease by medication often becomes a question of economics. A suitable drug may be available but the size of the flock may make therapy so expensive that the cost of treatment must be weighed carefully against the potential results. The value of medication will depend to some extent on the speed and accuracy with which a diagnosis is obtained, the correct choice of medicament and the adequacy of administration. Preventive medication is of value in a number of diseases, for example, coccidiosis, blackhead disease and mycoplasmosis. Efficient prevention depends on the accurate mixing of the drug, the correct dosage and adequate consumption. If feeding arrangements are such that a number of birds remain underfed they cannot obtain sufficient quantity of the medicament to maintain protection. This is how some apparent breakdowns in the efficiency of coccidiostats occur. Similarly, the protective effect can be reduced by sheer weight of infection and this can occur if patches of litter are soaked by overflowing drinking vessels.

Then there is vaccination. Every flock owner should seek professional advice as to the type of vaccines and the schedule of administration most suitable for his location and requirements. A correct schedule is essential if the risks of waning immunity are to be avoided. It must always be remembered that any vaccine can do no more than fulfil the purpose for which it was intended. The risk that a complex of respiratory disease may occur necessitates due attention to other potential infections and the factors which predispose a flock to them. All birds in a flock must be vaccinated and all should have the same vaccinal status. This is of particular importance when a laying flock is composed of birds from more than one source.

Planning for disease prevention

A plan to reduce the risks of infectious disease must be based on preventing its entry where possible, reducing the amount and types of infection, and ensuring that it does not persist on a premises. The extent to which planned prevention is practicable depends on a number of factors and is obviously easier when starting a new enterprise than adapting an existing one. The actual location, and the number and size of the flocks in the neighbourhood, are important. There are some areas where it might well be considered foolhardy to start a new enterprise. The larger the flocks around, the greater the risk of wind-borne infection. The distance between flocks and the direction of the prevailing winds are factors to be considered as part of the basic planning. There are many advances in housing and equipment and full use should be made of them. But all improvements do not necessarily suit all types of enterprise and it is advisable to make sure that any fresh introduction will fit in with the existing features. For example, it is no use fitting larger fans if the air inlets are inadequate.

Stock should be obtained whenever possible from the same source and, in the case of point-of-lay pullets, reared under the same conditions. If all the birds on a site are of the same age, so much the better. This lessens the risk of mixing infected and non-infected birds, or of spreading infection from older groups to younger ones. But stocking-up should be a rapid process, or all the birds cannot be of the same age group as, for example, when a broiler site is so large that it takes three weeks to get all the chicks in. This is of particular importance if trouble through mycoplasmosis is to be

avoided. The condition is egg-borne and spreads slowly, but it may have become established in chicks three weeks old and present a heavy infection to day-old chicks then brought into close contact. Similarly, if it takes three weeks to clear a site when birds are slaughtered, the period of complete depopulation is reduced, unless the flock owner intends to reduce the number of crops per year, which might well be economically impossible.

Disease-free stock

The need to reduce the amount of contact between flocks to a minimum is generally well realized and the necessary precautions are probably better practised in the poultry industry than in most other branches of animal production. Standards vary, of course, and reliance is sometimes placed on a disinfectant footbath long after its efficacy has been impaired by the presence of mud and the passage of time. Earth floors persist, but they are not satisfactory if a high standard of hygiene is to be maintained. Complete disinfection between each batch of birds is desirable. Some modifications may be made but this must be considered as a calculated risk. Where the record of health is good, it may be enough to replace the litter in the brooding area of a broiler house and leave the rest for a couple of batches if it is in good condition. But a risk still exists, and it is inadvisable to place too much reliance on the fact that the last batch went through without trouble. They grew up in that environment and may have developed resistance to a low-grade infection. The new chicks coming in may be susceptible and meet enough infection to cause clinical disease. A disinfectant must be effective, easily applied, cause no damage to the materials on which it is used, and have no harmful effects on those using it. It must be active in the presence of organic matter, keep stable during storage for a reasonable time, and be fairly cheap. Many types are available, and advice can be obtained from veterinary surgeons, Veterinary Officers of the Ministry's Animal Health Division, or County Poultry Husbandry Advisers.

The ultimate aim is to produce and maintain stock free from disease. Such an achievement would be greatly assisted by a more complete knowledge of the environmental and nutritional requirements of the various types of poultry kept. At present much can be done to reduce loss through disease by using suitable methods of vaccination and preventive medication, combined with hygienic measures, foresight in planning and the skills of husbandry.

Brian S. Hanson, M.R.C.V.S., joined the Ministry's Animal Health Division in 1951. After four years on the field staff, he became a Senior Research Officer in the Poultry Department of the Central Veterinary Laboratory, where he has since been engaged on diagnostic work.

New mechanical bean pickers working in relays in a Wisconsin snap bean field

Horticultural Progress in the U.S.A.

W. John Wright

THE International Horticultural Congress meets every four years in a different country, and it was appropriate that the recent seventeenth meeting, the largest since the congress began in 1889, should have been held in the United States. This time there were some 1,900 delegates, representing 22 countries. Some, from the far west of America, were prevented from attending by the internal air strike and there were stirring tales of endurance from other determined delegates who had travelled for seven days by car to attend—eloquent testimony to the size of the country!

If all the papers had been presented in sequence, the congress would have lasted, excluding excursions, some eight working weeks. It was only by running many of them concurrently that the proceedings were telescoped into a week. It would have taken one of the many computers used by the American research workers to work out which papers to attend to cover any wide range of interests. In fact it was impossible for any individual to get more than a broad idea of what was happening in any particular field, although the subjects ranged widely and included tropical crops as well as temperate ones, breeding, irrigation, mechanization, fertilization and so on. The congress was started with the sobering thought that world population was likely to double in 23 years and food supply was vital.

Mechanical harvesting

Understandably there was a good deal of interest in the progress with machine harvesting which was reported. The problem in the United States is not so much labour cost as its unavailability. Only the poorest class of people are employed permanently on the land, although numbers of Puerto Ricans work seasonally in the industry. The big source of migrant labour was Mexico but this has now been cut off, stimulating tremendously the work which had already begun on harvesting machines. These are not always of incredible complexity. Some are in effect huge mobile packing sheds. The workers cut the crops by hand and put them on to conveyors attached to these machines which are pacing them: these could be described as mechanical foremen! On the platform the produce could perhaps be washed, then graded, wrapped and packed and put on an attendant lorry.

Tomatoes are grown on a field scale, largely for processing, and it has been estimated that in California 75–80 per cent of this year's crop will be machine harvested. The plants sprawl along the ground, are cut off just above soil level and conveyed, haulm and all, to shakers which detach the fruit. This is graded by workers on the machine before packing. Cultural practices are being re-examined to produce a maximum harvest at one time for once-over gathering. Work was described, in the case of the field tomato, on the use of chemical growth depressants to concentrate fruit ripening into a shorter time by killing unopened flower buds once an economic crop had begun to develop.

Asparagus is widely grown and a band-saw type of harvester is being used for non-selective harvesting. Now a sensing device is being tried out so that only mature spears are cut. A similar device is being tried for selecting hearted lettuce for machine harvesting. Gherkins are a widely-grown field crop and here, too, work was described on a machine harvester which lifts the entire crop and pulls fruit off the plants. In this case a weed control chemical is being sought. There has been a general tightening up on weed control procedures (the machines will not work in too weedy conditions) and work is in hand on breeding to get uniform maturity and easier detachability of fruit, in seeding rates for maximum stand, on water and fertilizer application rates to minimize top growth where this would interfere with harvesting as in potatoes, and on hydro-seeders to get uniform, rapid establishment.

Fruit picking

Other mechanical devices described are as simple as huge tractor-mounted frames from which are suspended individual platforms, and from these operators can work on crops. In the case of apples and sour cherries individual branches are shaken mechanically and the fruit, suitable so far only for processing, is caught and tipped into boxes for transport. It was reported for sweet cherries that 80–85 per cent of the potential crop was marketable after shake harvesting and that the saving in labour offset this loss. The blackberry is regarded as a natural for machine picking because the mature fruit shakes off so easily and is quite resistant to damage during harvesting. Raspberries are being trained at an angle so that 'shake-catch' machines can be worked more easily. Strawberries are proving more difficult but a combing device for pulling off the fruit is being tested. Dessert apples are being grown more in hedgerows, on British Malling rootstocks, with tiers

A tractor-mounted boom shaker removes tart red cherries which are caught by a circular collecting unit

of branches up to, say, 14 ft. These are picked by hand from a multi-level platform which is drawn down the rows, the fruit being conveyed to a bulk bin carried underneath. Now more dwarfing rootstocks are being sought for other fruits, e.g., plums, peaches, to bring the bearing area down nearer to the ground for platform or machine operations.

The glasshouse industry

The American glasshouse industry is small on account of high summer temperatures (Washington is at the same latitude as central Spain and Greece) and the easy transportability of early crops from favoured southern states. The trucking of lettuce under refrigeration from California across the continent to the heavily-populated eastern seaboard has practically eliminated this crop from the eastern states. Now, before transporting, much of this produce is vacuum-cooled in vessels large enough to take an entire truck. The principle of the process is that, at very low pressures, water will boil at 32°F. In so doing it absorbs heat. Thus the moisture in the lettuce is extracted and at the same time the heads are cooled without becoming limp, the whole process taking only 4–6 minutes.

The use of carbon dioxide on crops under glass has brought big improvements in the production of many crops, e.g., greater weight, earliness, better quality. It appears that established practices based on growing without CO_2 enrichment will now have to be re-examined. Lettuce receiving CO_2 are found to respond to more nitrogen, other crops to supplementary lighting. Varieties more responsive to CO_2 are being sought. It was generally reported that CO_2 was more effective if the atmosphere was kept moving by circulating air, enriched with CO_2 or not, with fans.

Use of chemicals

The effects of chemicals cannot always be predicted from their composition and there is always the possibility of an exciting new use being discovered. There has been just such an occurrence following a chance observation that an overdose of DDT emulsion on a certain variety of chrysanthemum eliminated the need for time-wasting disbudding by hand. This was traced to the solvent in the spray which was closely related to napthalene (moth balls). Unfortunately only three varieties of chrysanthemum respond, but

similar compounds are now being used to 'stop' the growth of plants chemically. This is not as time-consuming as disbudding but chemical stopping gives more even and better side shoot growth than hand pinching. This treatment, combined with a growth-depressant spray to dwarf plants and stimulate flower bud formation, has opened the way to growing azaleas the year round as a pot plant when combined with existing methods of treatment to promote flowering. The United States Department of Agriculture have developed this method up to the stage of commercial adoption by their work at the Plant Industry Station, Beltsville.

Also on display at Beltsville were field-grown cucumbers mulched with aluminium sheet which has been found to repel greenfly. As well as the reduction of virus infection in the plants, moisture supply and soil temperature can be favourably affected and the fruit protected from splashing.

Heat retention

Although glasshouses are designed to make maximum use of free sunlight and energy, they are inefficient structures for heat retention. However, the energy requirement for tomatoes is so high that at present the cost of artificially lighting insulated chambers is quite uneconomic. The Beltsville scientists have found some crops, however, that can be grown with benefit under these conditions and this could find commercial application. Bedding plants like petunia and antirrhinum can be brought to a saleable condition quickly with artificial lighting, a temperature of 65–70°F, and a carbon dioxide enriched atmosphere.

Growers in the States have become interested in polythene-covered glasshouses as temporary protection, for example, to harden off bedding plants. They accept that, due to the damaging effect of sunlight, the polythene has a life of less than twelve months and design house frameworks for easy

Catcher-conveyor developed by the U.S. Department of Agriculture. Fruit shaken from the trees falls on to a large, endless belt which conveys the fruit into boxes or crates

re-covering. A double skin is preferred to reduce heat loss and control condensation. In the north-eastern states they may have thirty inches of snow at one fall and recommend single houses so that this load can slip off. Corrugated fibre-glass is also being tried experimentally as an outer cover with polythene inside. An addition to the polythene increases resistance to sun.

Revolution in marketing

The supermarket revolution is almost complete in the United States and has caused a corresponding upheaval in marketing. The use of transparent film for packaging has now embraced most crops sold fresh and is used in many cases to reduce water loss and give some control of the atmosphere for stored produce. The California-grown carrots and green celery available in this country at certain times of the year are a sign of this modern miracle of technology.

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The Ministry's Publications

Since the list published in the October, 1966, issue of *Agriculture* (p. 507) the following publications have been issued.

MAJOR PUBLICATIONS

Bulletin No. 149. Farm Grain Drying and Storage (Revised) 13*s*. (by post 13*s*. 9*d*.)

Experimental Husbandry Farms and Experimental Horticulture Stations 7th Progress Report, 1966 (New) 8*s*. (by post 8*s*. 6*d*.)

ADVISORY LEAFLETS

(*Price 4d. each—by post 7d.*)

No. 17. Swine Erysipelas (Revised)
No. 40. Small Ermine Moths (Revised)
No. 168. Pullorum Disease (Revised)
No. 305. Bryobia Mites (Revised)
No. 372. Potato Tuber Eelworm (Revised)
No. 427. Feeding Turkeys (Revised)

FREE ISSUES

Farm Safety—Guns

STL No. 23. Chemical Weed Control in Strawberries (Revised)

The priced publications listed above are obtainable from Government Bookshops (addresses on p. 556), or through any bookseller. Unpriced items are obtainable only from the Ministry (Publications), Tolcarne Drive, Pinner, Middlesex.

Rothamsted Reports

Sylvia Laverton

THE 375-page report on the work done by the Rothamsted Experimental Station in 1965 contains broadly three kinds of information: experimental results that have an immediate bearing on present farm practice; records of longer-term investigations likely to shape future changes in farming methods; and accounts of fundamental researches designed to provide a clearer understanding of the nature of soils, plant growth and crop health. As always, it includes much useful and thought-provoking material for the farmer.

Effects of soil sterilants

Evidence of the extent to which soil-borne pests and diseases limit yields when cereals are grown intensively is accumulating from recent experiments with soil sterilants. These studies began in 1964 as an investigation into scorch—a trouble that affects wheat and barley grown on light sandy loam at the Woburn Experimental Station. On this light land, which has been used for arable crops for many years, cereals that look promising in spring are liable to deteriorate in late May or early June, particularly if the weather then is unusually dry. Many plants shrivel and the ears do not emerge. Later rain brings no improvement. This condition, which is associated with the presence of the brown foot rot fungus, is most serious in dry springs in crops given abundant nitrogen.

The causes of scorch were sought by partially sterilizing the soil with formalin; adding a fungicide (nabam) to the soil; watering at the critical period; and giving different amounts of nitrogen fertilizer. The effects of these treatments on spring wheat were measured by sampling the crop at intervals and by estimating the incidence of cereal root eelworm and of soil-borne diseases. Though the experiment failed in its main purpose—scorch did not occur, probably because the 1964 spring was wet—formalin treatment produced striking results. It doubled the grain yield and nearly doubled the straw. On watered plots, given 1·2 cwt fertilizer N per acre, the grain yield was 37 cwt per acre where formalin had been applied, but only 18 cwt without formalin. The main effects of formalin were to diminish attacks by cereal root eelworm and the take-all fungus.

Take-all: chemical control

Last year the experiment was continued at Woburn and extended to Rothamsted. At Woburn, freshly-applied formalin nearly trebled the yield of spring wheat on land where this was the third successive wheat crop, but the previous year's application had no residual effect. At Rothamsted, take-all and eelworm are less damaging than on the lighter Woburn soil. Nevertheless, on Little Knott field, where cereals have been grown intensively for twenty years, formalin considerably increased the spring wheat yield and decreased the incidence of take-all, eyespot, and cereal root eelworm. On another Rothamsted site, Pastures Field, recently ploughed from grass and virtually free from soil-borne pests and diseases, no gain resulted from formalin treatment.

The Woburn results suggest that the prevalence of take-all in wheat may not be proportional to the amount of residues left in the soil. In 1964, formalin reduced the percentage of plants infected with take-all to 1 per cent, but in 1965, 45 per cent of the wheat grown on the same plots, which had received no more formalin, was infected. Thus it seems that a crop with as few as 1 per cent infected plants may leave enough fungus, *when evenly distributed*, to cause severe take-all in the following crop. This idea, if correct, has important practical implications for the chemical control of take-all. Clearly, if the aim is to kill the fungus in the soil, the material used must be either cheap enough to use every year, or so effective that the amount of fungus surviving treatment is very much less than that needed to infect only 1 per cent of the crop. Neither of these conditions will be easy to fulfil. Preventing crown-root infection in early summer, perhaps by using a systemic fungicide, appears to be a more promising approach.

Fertilizers and potatoes

N.A.A.S. experiments during the period 1955–61, designed to test the effect of standard levels of fertilizer for maincrop potatoes, showed that responses to phosphorus were greater than expected (*J. Agric. Sci.*, **63** (1964), 249-63). Early work on placing fertilizers for potatoes is obsolete, as it was done with much smaller dressings than are now used. To devise safe methods of using large dressings and to measure their residual effects on following crops, a new series of experiments has been done by the Rothamsted Chemistry Department. The results given in this Report refer to work on Clay-with-Flints, Oxford Clay and Chalky Boulder Clay.

Yields of tubers were greatly increased by fertilizer treatment. There was a worthwhile additional increase from broadcasting, though not from placing, 15 rather than 10 cwt per acre of the compound fertilizer used (13–13–20). This manuring (2·0 cwt N, 2·0 cwt P_2O_5 and 3·1 cwt K_2O per acre) is much larger than that currently recommended, but was justified in these experiments when correctly applied. Broadcast fertilizer, whether applied on the ploughing or on the seedbed, gave similar yields at both 5 and 10 cwt per acre, but for 15 cwt per acre broadcasting on the ploughing was usually the better method. At this rate of application, band placement beside the seed was always inferior, presumably because it checked early growth, so broadcasting is preferable on soils that need large fertilizer dressings.

Saxmundham Experiments

Since 1964 the Saxmundham Experiments, started in 1899 by the East Suffolk County Council, have been Rothamsted's responsibility. The manuring used in the famous Rotation I Experiment remained unchanged from 1899 to 1965. Now the main part of each plot in this experiment has been modified to make it useful in studying the manuring of crops that can be grown in the farming systems possible on this difficult stiff clay loam. The aim is to produce consistently high yields from a rotation suited to the area, identifying the causes of any poor crops and correcting faults in the manuring.

The new experiment will also show the value of the phosphorus reserves accumulated from past manuring, and of the potassium supplies from the soil minerals. The potassium test will be none compared with 1·0 cwt K_2O per acre. At present, even after 65 years' cropping, there are only small responses to potassium fertilizers. The larger crops that will be grown with more nitrogen (0·5 and 1·0 cwt N per acre will be compared) will considerably increase the amounts of potassium removed. Information about how much can be supplied from this 'K-release' soil, and how long the supply can continue, is important both in farming soils of this kind and in the Rothamsted research on potassium fixation and release.

The Rotation II Experiment was modified in 1965 to measure residues of phosphorus applied between 1899 and 1964. In another new experiment started last year on plots of the Rotation II Experiment abandoned in 1952, the aim is to measure the incidence of take-all and eyespot and to see how these diseases affect wheat yields and responses to nitrogen fertilizer—a subject on which few experiments have been made so far in East Anglia.

Inoculating leguminous plants

The advantages of inoculating leguminous plants, especially lucerne, with appropriate symbiotic nitrogen-fixing bacteria were demonstrated at Rothamsted many years ago and since 1926 inoculants have been prepared and marketed in this country by one particular firm under an arrangement whereby Rothamsted provided parent cultures and tested every thousandth culture sold. This firm has now stopped selling inoculants and, unless some action is taken, British farmers will in future be able to buy only imported ones, for which there is no testing scheme to ensure their reliability.

The inoculation of non-leguminous plants is customary in Russia and eastern Europe where it is claimed that the yields of various crops are increased by *Azotobacter* or other 'bacterial fertilizers'. At Rothamsted benefits from inoculation with *Azotobacter* have occasionally been observed. The cause is not yet clear, though experiments have demonstrated that it is not attributable to nitrogen-fixation. One of the few crops that responds consistently to *Azotobacter* is the tomato. In 1962 and 1963, tomato plants treated with *Azotobacter* at the roots at transplanting time formed flowers and fruit earlier than untreated plants. In 1964 the same effect was found in plants grown from inoculated seed, and both root and seed treatment also increased the stem height and leaf length of seedlings. Last year, further experiments in collaboration with the Lee Valley Experimental Horticulture Station confirmed and extended these results. The growth effects resemble those caused by gibberellins, and hormones of this type have been found in *Azotobacter* cultures.

Liquefied Ammonia in Agriculture

R. S. L. Jeater

LIQUEFIED (anhydrous) ammonia is the most concentrated form of nitrogenous fertilizer, containing 82 per cent nitrogen. At normal temperatures and pressures it is a gas which fumes with moisture in the air, but is a liquid at high pressures. It must be stored and transported in cylinders or tanks capable of withstanding pressures of not less than 250 lb per sq. in., hence both storage and transport are expensive in terms of capital equipment.

Limitations and early trials

Handling ammonia under pressure can be dangerous unless strict precautions are taken and adequate safeguards are quickly available in case of accidents. Because ammonia is a gas under normal conditions it must be injected into the soil to avoid losses in the air, hence special application equipment is required. Liquefied ammonia has been used widely in the U.S.A. for some years, primarily in wide-row crops such as maize and cotton. For narrow-row crops such as wheat or barley or for grassland the injector tines have to be set much closer together resulting in a greater drawbar pull per foot of tool bar and a reduction in the working width of the machine for any given amount of power. Injection is therefore a slow operation under these conditions. These limitations have meant that liquefied ammonia has not, up to now, been seriously considered as a nitrogenous fertilizer in the United Kingdom, even though it has the advantage of the higher percentage nitrogen compared with solids. However, this material is beginning to be used on the Continent, particularly in Denmark and France.

Preliminary work with liquefied ammonia was carried out at Jealott's Hill in 1956 and 1957. This was reported by Jameson in the *Journal of Agricultural Science*, Vol. 53, 1959. More recently further trials have been conducted at Jealott's Hill and in Southern England and East Anglia on grass, winter wheat, spring barley, sugar beet and potatoes.

Grassland

Grassland, where nitrogen is often applied as a straight fertilizer without P or K, offers the most obvious potential for liquefied ammonia. A trial

on Cotswold brash compared liquefied ammonia with 'Nitram' at application rates of 67 and 135 lb nitrogen per acre. The fertilizers were applied twice, once in March and once in May. Two cuts were taken following the first application and a further two cuts after the second application. The yields of dry matter obtained from the four cuts are given in Table 1.

TABLE 1

Dry matter yield of grass

(cwt per acre)

Fertilizer	*Cut 1*	*Cut 2*	*Cut 3*	*Cut 4*	*Total*
Liquefied ammonia					
67 lb/N/ac. applied twice	7·5	9·3	18·8	26·6	62·2
135 ,, ,, ,,	8·3	11·9	24·7	36·7	81·6
'Nitram'					
67 lb/N/ac. applied twice	12·5	6·9	26·6	21·9	67·9
135 ,, ,, ,,	16·2	10·0	30·3	28·7	85·2
Control no fertilizer	4·4	3·3	8·9	32·8	49·4
Sig. diff. (P = 0·05)	1·7	1·5	2·9	2·6	4·6
Fertilizer averaged over N rates					
Liquefied ammonia		10·6	21·8	31·7	71·9
'Nitram'		8·4	28·4	25·3	76·5
Sig. diff.		H. Sig.	H. Sig.	H. Sig.	H. Sig.

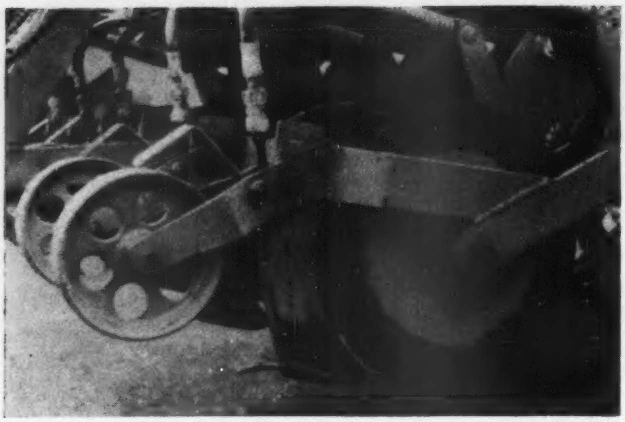
Over the four cuts there was a greater response following the use of 'Nitram' than after liquefied ammonia. At the first cut after application of the fertilizers, i.e., cuts 1 and 3, 'Nitram' gave bigger yields than liquefied ammonia, whereas at the second cut each time, cuts 2 and 4, the reverse was the case, although the increases were not sufficient to compensate for those obtained from 'Nitram' at the first cuts. The actual injection of the liquefied ammonia causes some damage to the grass sward and its action is slower than 'Nitram' as it has to be converted into an available form. Hence it can be argued that it would be better to inject all the liquefied ammonia for the whole season in one application to reduce the tine damage and the effect of the slower availability. With this in mind, a further trial was conducted at Jealott's Hill where all the liquefied ammonia was injected in the spring and an equivalent rate of 'Nitram' was applied in the normal manner in three split applications throughout the season. Three cuts were taken, in May, July and October, and the dry matter yields are given in Table 2.

TABLE 2

Dry matter yield of grass

(cwt per acre)

Fertilizer	*Cut 1*	*Cut 2*	*Cut 3*	*Total*
Control no fertilizer	19·1	20·9	13·7	53·7
Control no fertilizer plus injection tines	16·4	17·7	15·4	49·5
Liquefied ammonia				
230 unit N/ac. in one application	27·8	26·8	20·2	74·8
'Nitram'				
230 units N/ac. broadcast in three applications	31·3	26·1	24·9	82·3
Sig. diff. (P = 0·05)	3·2	3·8	2·8	7·0



This photograph and the one on p. 545 (opposite) show different types of equipment for injecting liquefied ammonia into grassland

Here again the liquefied ammonia gave a smaller response than 'Nitram' at the first cut. It gave a similar response only at the second cut and was again less effective at the last cut. Overall 'Nitram' gave nearly 8 cwt per acre more dry matter than the liquefied ammonia, an increase of about 10 per cent. As injection is a slow process, it might be necessary to extend the injection period back into the previous autumn and winter for grassland. To investigate the effect of this, a trial was put down at Jealott's Hill comparing autumn and spring injection of liquefied ammonia with autumn and spring application of 'Nitram'. Three cuts were taken during the season, in April, June and August, and the dry matter yields are given in Table 3.

TABLE 3

Fertilizer	*Cut 1*	*Cut 2*	*Cut 3*	*Total*
Control no fertilizer	4·2	20·3	12·4	36·9
Liquefied ammonia				
120 units N applied autumn	13·1	27·9	11·4	52·4
120 ,, ,, ,, spring	4·5	37·0	13·6	55·1
'Nitram'				
120 units N applied autumn	14·2	29·7	12·7	56·6
120 ,, ,, ,, spring	11·1	38·9	13·2	63·2
Sig. diff. (P = 0·05)	3·8	3·0	Not Sig.	6·4

The winter of 1964–65 was dry and it is unlikely that much nitrogen was lost by leaching. There was a very good response at the first cut to liquefied ammonia applied in the autumn and to 'Nitram' applied both in the autumn and in the spring. Evidence of the slow action of liquefied ammonia was shown at the first cut, where the spring application gave a similar yield to the control which received no nitrogen. At the second cut all the nitrogen treatments showed a response over the control, the largest response coming from 'Nitram' applied in the spring which was very nearly matched by liquefied ammonia applied in the spring. Response to 'Nitram' and liquefied ammonia applied in the autumn was similar. Both of these gave lower yields at the second cut compared with equivalent spring applications. By the third cut all treatments, including the control, gave similar yields.

In all these trials liquefied ammonia was not able to match 'Nitram' in efficiency as a nitrogenous fertilizer for grassland, with the yield differences ranging from 4 to 20 per cent in favour of 'Nitram'. The slow action of

liquefied ammonia when applied in the spring would necessitate application over winter, and in some years this could be a difficult operation due to the state of the ground. At Jealott's Hill in 1965–66 injection into grassland was not possible between early December and early March because the ground was too wet and considerable damage was caused by both the injection tines and the tractor wheels when it was attempted. Also, in a wet mild winter some loss of nitrogen would be expected and this would be reflected in yields throughout the following season.

Winter wheat

Straight nitrogen is also used on winter wheat. Seven trials were conducted in 1965 on a number of soil types including heavy loam, medium loam, chalk, limestone and gravel. Overall, the yields following the application of 'Nitram' were about 2 cwt grain per acre (adjusted to 85 per cent dry matter) more than those after liquefied ammonia. However, the time of application of the fertilizer had a considerable effect on the relative efficiency of the two materials, as shown in Table 4.

TABLE 4

Difference in winter wheat grain yield between 'Nitram' and liquefied ammonia

Application period	*Grain yield difference in favour of 'Nitram'* (cwt per acre)
11th–17th April	0·6
18th–24th April	0·9
24th April–1st May	2·4
2nd–8th May	6·6

From these figures it is obvious that the later the time of injection the greater the differences in favour of 'Nitram' because of the damage from the injector tines which increased as the crop developed, and from the slower action of the liquefied ammonia. It seems probable, therefore, that liquefied ammonia injection to winter wheat would have to start in the spring to cover any reasonable acreage and to reduce the tine damage and allow the liquefied ammonia to become available. Further experimental data are, therefore, required on the yield response of winter wheat to liquefied ammonia injected in March or even earlier.

Grassland injection in progress

Spring barley

For much of the spring barley grown in the United Kingdom compound fertilizers containing N, P and K are used. Liquefied ammonia will only supply the nitrogen; hence the P and K has to be applied separately. Ten trials were conducted in 1965 comparing liquefied ammonia plus matching P K with I.C.I. No. 2 (22 : 11 : 11) at equivalent nitrogen rates. All the fertilizers were applied before drilling, with the solids being broadcast. Trials were conducted on a number of soil types including clay, medium loam, light loam, chalk limestone and gravel. Averaged over all the trials, the yields from the two forms of nitrogen did not differ significantly. There were a number of cases where 60 units of nitrogen were applied, notably on the chalk where liquefied ammonia was slightly more efficient than solid nitrogen, but in one of these the highest yield was, in fact, given by the control which received no fertilizer. Some difficulty was experienced with the even injection of the low rate of ammonia.

Sugar beet

As with spring barley, the fertilizers normally used for sugar beet are compounds containing NPK, and again where liquefied ammonia is used the P and K has to be applied separately. Eight trials were conducted in 1965 using liquefied ammonia with matching P and K compared with solid compound fertilizers. All the solid fertilizers were applied before drilling and the liquefied ammonia was injected, either before drilling or at singling. Where the liquefied ammonia was applied before drilling, the yields of both beet and sugar were exactly the same as from the compound fertilizers when averaged over all the trials at both rates of nitrogen, 100 and 150 lb per acre. The yields from the liquefied ammonia injected at singling gave about 0·5 ton per acre less of clean roots and 2 cwt per acre less sugar. Liquefied ammonia has to be injected before sowing to be as effective as solids, and the season of injection cannot be increased by continuing up to the time of singling. Once again it seems probable that, to cover any reasonable acreage, injection would have to start in the winter on the plough furrow and further data on the effect of this on the yield of beet will be required.

Potatoes

Ten trials were conducted comparing liquefied ammonia plus matching P and K with solid compound fertilizers on potatoes. As with the sugar beet all the solids were applied prior to planting. There were two times of application of ammonia, either prior to planting or after planting. All treatments showed a very good response over the control. Liquefied ammonia applied prior to planting gave 0·8 ton per acre less than the solid fertilizer averaged over ten trials when used at 100 units nitrogen per acre, and 0·5 ton per acre less at 168 units nitrogen per acre. When applied after planting, it yielded about 1·0 ton per acre less than the solids at both rates of application. As in the sugar beet trials, when ammonia is applied before planting there is little difference between it and solid fertilizers. Injection immediately after planting is not quite so effective as injection before planting.

Conclusions

An extensive programme with liquefied ammonia has shown that, in general, where it is used immediately prior to sowing or planting with matching P and K it is as effective as compound solid fertilizers for spring barley, sugar beet and potatoes. It remains to be seen if, on a large scale, this approach offers any advantage over solid compounds as the P and K have to be applied separately, requiring two operations where one is now sufficient. Rate of work of injection machinery is slow; hence to cover any large acreage injection would have to start in the winter, with its attendant difficulties on wet land. Also data would be required to determine whether applying liquefied ammonia at this time is as effective as applying it just before sowing.

For winter wheat, the injection would have to be started early in the year both to get the acreage treated and to reduce the damage from the tines. In a wet spring this could be a difficult operation especially on heavy soils, and again further data are required to determine whether the response of the wheat to this early injection is as good as that from solid forms of nitrogen. The experience on grassland in this series of trials has shown that liquefied ammonia is less efficient than 'Nitram', even when steps have been taken to inject it as one large dose, either in the spring or autumn. It also has the disadvantage that the growth pattern of the grass cannot be modified so easily as with solid forms of nitrogen.

Before a complete evaluation of the potential use of liquefied ammonia under U.K. conditions can be made, a considerable amount of further data are required on its efficiency, especially with regard to time of application over a number of seasons. The technical data must then be considered together with the problems of storage and application and safety to the operator.

R. S. L. Jeater gained a first-class Honours degree in Agricultural Botany and Botany at the University College of North Wales in 1952 and subsequently spent four years at the National Institute of Agricultural Botany before joining Imperial Chemical Industries Ltd. After three years at Fernhurst Research Station he moved to Jealott's Hill, where he is now Head of the Field Trials Section. Mr. Jeater has worked in Argentina on weed control in lucerne, and he also developed paraquat for weed control in rubber and oil palm in Malaya.

46. Chanctonbury, West Sussex

N. I. Gilder

THE district takes its name from the conspicuous clump of beech trees which stands nearly 800 ft above sea level on the South Downs near the seaside resort of Worthing. This, the highest point, may be seen on a fine day by the traveller in the Sussex Weald from many miles distance. The boundaries of the area are the coastline, now all built upon, extending from Littlehampton to a point three miles west of Brighton, where Sussex is divided for administrative purposes; the county boundary northward to the new town of Crawley; and thence in a south-westerly direction very approximately following the A29 London-Bognor road.

Climatically, the district is favoured. Places on the south coast record a mean daily figure for sunshine of about five hours, which is higher than elsewhere in Britain, though this falls a little inland. Annual totals of rainfall vary with elevation from rather more than 25 in. to 35 in. There is much variation in the soils, all of which are included in the Wealden area of South-East England, the term being used in its wider sense.

Near the coastline the chalk is overlain by a fertile brickearth, resulting in a narrow coastal plain well suited to arable farming and horticultural crops. The valuable glasshouse industry is concentrated here, among the ever-increasing human dwellings, and specializes in the production of tomatoes and flowers. The Glasshouse Crops Research Institute is at Toddington, near Littlehampton.

The South Downs are themselves chalk and rise gently from the coastal plain, but they have a steep northerly scarp. Much of this area was in military use during the 1939–45 war, but has since been restored and equipped for farming. So rapid has been the change in farm building design that already there are instances where structures erected by 1950 no longer meet requirements. The farm units are large and cereal growing is the main feature of the farming systems. Nevertheless, nearly all have stock and this, in most cases, includes the dairy herd, usually black-and-white. Most are loose housed in winter; others remain outside and feed on strategically-placed silage, kale and rape. Where continuous cereal cropping is practised, the expected soil-borne fungus diseases are found and cereal root eelworm appears from time to time. However, at present these conditions are not a major problem. Annual sales of sheep are held in late summer at Findon and in days gone by these were major events in the calendar for breeders of the Southdown sheep. Today, with folding of arable crops outmoded, sheep in the district are either grassland breeds from the Welsh or Scottish borders or crosses between these and Down types.

Northward from the South Downs and roughly parallel from west to east, lie narrow bands of Upper Greensand, Gault and Lower Greensand. These are not everywhere represented at the surface, and the two former seldom occupy more than a few fields on any one farm. The Upper Greensand is a potentially productive soil but suffers in this district because it is situated immediately below the north-facing scarp of the Downs. The Gault is a heavy, badly-drained soil, and its presence may often be detected by the small permanent grass fields found upon it. Beds of Lower Greensand, Folkestone, Sandgate and Hythe all occur at various places, the deeper Lower Greensand soils being free-draining and fertile if well managed. They are not extensive and are much sought by fruit growers and nurserymen. Most farms here are of medium size, classified in farm management terms as 'milk with arable'. The long season of grassland use which the Greensands allow is important to the dairy farmer, provided there is adequate water.

Near Horsham, and occupying about one-third of the district, is an area of Weald clay. This is heavy land and its improvement in most instances has to start with attention to drainage—expensive work involving tiled mains which can sometimes be laid in combination with laterals drawn by a mole plough. The area is extensively wooded, often with small fields divided by 'rews', perhaps a chain wide and growing oaks and hazel. Many of the farms have a 100 acres of land or less. Income used to be derived almost entirely from dairy herds housed in cowsheds through long, expensive winters. Progress-minded farmers have developed the skills of management on improved pastures, generally following reseeding, but utilizing the grass which has been grown early and late in an extended season presents problems on heavy, water-holding soil. As stocking rates have increased so have yards and milking parlours replaced cowsheds. Landlords financing such developments have been forced to think very carefully on farms of small acreage, and on several estates the outcome has been that, as tenancies have expired, larger units have been created by amalgamation of holdings. These have been equipped for modern dairying and economic rents charged. In this situation the tenant on the increased acreage often finds that corn-growing is a proposition on acres which can be released from grass. This frequently involves the piping of ditches, removal of hedges and creation of larger fields. Farmhouses on the clay are generally old and picturesque, and are often roofed with the attractive Horsham stone found locally within the Weald clay formation. With central London less than 40 miles away, it is not surprising that many are now divorced from the land and occupied by those who do not live thereby. The Tunbridge Wells Sand outcrops south-east of Horsham and is farmed mostly in grass with a dairy herd. Within the district the acreage is not large.

Drainage from the Wealden basin in West Sussex is by the Rivers Arun and Adur which flow southwards through gaps in the chalk downs to enter the sea at Littlehampton and Shoreham respectively. Both are flanked, especially north of the chalk, by considerable areas of riverside meadow, known as 'brooks'. These are on alluvium, but some Arun brooks contain peat. Periodic flooding, often for whole winters and sometimes in summer also, has always made their management difficult. Summer grazing seasons are short by comparison and there are no buildings. Work designed to alleviate this situation is now proceeding on the rivers and in the course of time limited areas may be ploughed and cropped. The naturalist will regret: the farmer will rejoice.

FROM THE ALS

B. W. Massey
Agricultural Land Service,
Worcester

In-barn Hay Drying by the Dutch System

To many farmers the haymaking season continues to be a period of frustration if reliance is placed solely on our unpredictable weather. The Dutch flue system provides one way of overcoming the difficulties. As this system enables the crop to be dried in an existing Dutch barn without side cladding, the initial capital cost of installation can be kept to a minimum. All that is required is a bung which forms and top seals a central vertical air duct into which air is blown from a fan mounted on top of the bung. By suspending this fan from a monorail fitted on the roof apex, two stacks or more may be dried by the same fan. It involves no additional labour costs, since the hay can be stored in stacks initially built to dry the crop. Furthermore, it may be possible to spread the capital cost over two enterprises by providing a fan suitable to serve the dual purpose of drying both hay and corn but using an underground duct.

This dual system has been successfully installed on Mr. Powell's farm at Willox Bridge, Herefordshire, which is a holding of 278 acres. Here, existing buildings were converted to such effect that 80 tons of hay built in two stacks, and 120 tons of corn stored on the floor, can be dried by using only one fan.

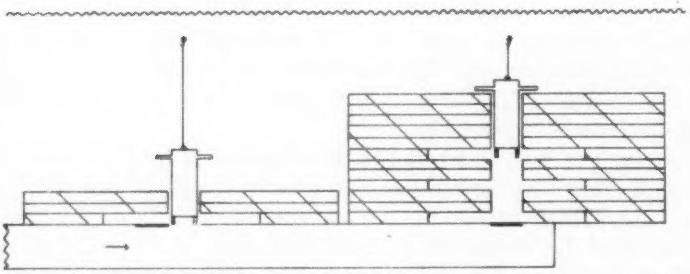


Fig. 1

Fig. 1 illustrates the layout for hay drying. Air is blown along the underground duct into a central vertical chimney, self-formed in the building of the stack. This results in minimum air resistance and comparatively low power requirements. Apart from the fan itself, the bung is the most important piece of equipment. The bung initially stands in the middle of the drying

hay and bales are stacked round it. As stacking progresses, it is raised by block and tackle, leaving a vertical chimney (air duct) at the centre of the stack. When the stack has been built, the bung is not removed but blocks the top of the chimney. Cold air which is blown into this chimney travels radially outwards in all directions through the stack of hay. Although retaining walls are not necessary, it is important to support the hay in some way. This may be done by erecting vertical supports at intervals round the perimeter of the stack. If two adjacent stacks are to be dried, care must be taken to ensure that there is a gap between them so that there is an adequate air flow through all four walls of the bales.

Assuming reasonable weather conditions, the hay is wilted for a period from 36–48 hours before carrying. As each layer of bales is loaded into the building the bung unit is raised a further stage. If, as is likely, the stack is square or of a rectangular shape, it will be necessary to form laterals to ensure that air reaches the corners. These laterals are best made by using wooden formers. An adequate through-put of air is provided if laterals are formed in the bottom, fourth, seventh and tenth layers of bales. The blowing of cold air is started as soon as possible after work has begun on loading the stacks. After 10–12 days of continual blowing, the fan need be used only intermittently according to the relative humidity. This system of hay drying should provide hay of a higher nutritional value with less loss through leaf shatter than if traditional methods are used.

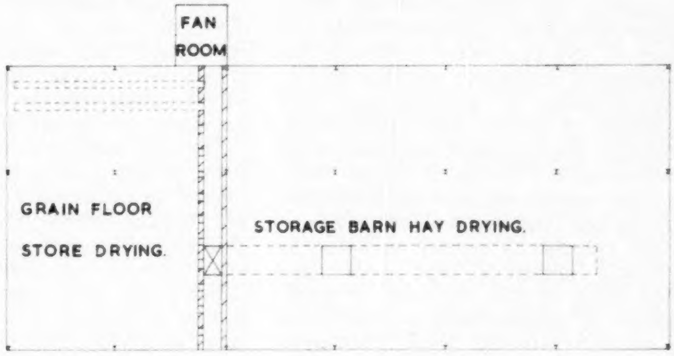


Fig. 2

The layout for hay and corn drying is shown in outline in Fig. 2. As can be seen, the underground ducting extends to two stacks which can be dried alternately. The fan is situated at the end of a long underground channel running the width of the building. At the one side of this channel is the duct leading to two stacks of hay. On the other side of the channel, laterals can be placed to provide an air flow through the corn which is stored on the floor.

On the economics of the system, running costs have been reduced to a minimum by using cold air to dry the hay, and they work out to no more than 10–12*s*. per ton of hay dried. On the experience of the past three seasons since the system was first introduced at Willox Bridge, Mr. Powell finds that he is able to produce higher-quality herbage and to harvest the crop more easily and with less anxiety. Moreover, by distributing the expenditure involved in the provision of a fan and underground channel over two enterprises, this method of drying hay is an economic proposition.

Books

Pests of Stored Products. J. W. MUNRO. Hutchinson, 1966. 42*s*.

It is appropriate that this new volume in an excellent series should be written by Professor J. W. Munro, because his energy and persistence alone has made possible the study of stored product pests in Britain and ensured a judicious blend of the academic, practical and commercial approaches to the subject. The book is written not for the specialist but for those interested in some aspect of infestation and its control, and these people will find it extremely readable. Considerable space is given to the elementary facts and terminology of entomology and such ecology and chemistry as are necessary, and something is written about every topic, especially among control measures, worth mentioning to this class of reader. 'Pests' in this context are entirely arthropod; rodents and fungi are not dealt with.

The introductory chapter on history is extremely interesting, and it is most encouraging to find the work of J. W. Siddorn on the measurement of conditions in microenvironments given prominence in chapter 3. The three chapters on the species of insects and mites are less satisfactory, but it is difficult in some 80 pages to give enough detail about the common important pests and also to mention the rarer species so that a general reader can tell which might be pests and which not. However, the fairly extensive literature lists at the end of each chapter enable the reader to follow up any points that take his interest. This is very necessary for control measures because many are dealt with very briefly and no attempt is made to give advice about which to use against specific pests.

In some respects this is an old-fashioned book in that it reflects the author's greater familiarity with the older work. This is frequently an advantage for presenting a general picture of principles, often with reference to other fields of applied entomology. It is strange, however, when discussing air-tight storage, to devote nearly two pages to the work of Dendy and Elkington some 45 years ago and not to mention the recent work of S. W. Bailey. Again, after the remark in the foreword on p. 10, I was disappointed with the treatment on p. 141 of 'heating', which has been extensively studied in recent years. I found one author's name and one generic name wrongly spelt, and one misleading reference.

No doubt other specialists will make similar criticisms, but this remains a very good introduction to stored products entomology by a man to whom all stored products specialists are greatly indebted.

R.W.H.

Animal Nutrition. P. MCDONALD, R. A. EDWARDS and J. F. D. GREENHALGH. Oliver and Boyd, 1966. 57*s*. 6*d*.

One reads with accelerating enthusiasm this book from the Edinburgh School of Agriculture. Each chapter is so good that at first one fears that the standard cannot be maintained into the next. These fears are dispelled early and do not return.

There are twenty-two chapters, the first seven of which cover the chemistry and some of the biochemistry of the constituents of biological material. They are admirably clear and, although condensed, nothing of importance has been omitted. The next two chapters deal with digestion and metabolism. Differences in the digestive processes of species of farm animals are fully discussed and the mysteries of ATP, NAD, FAD, RNA, DNA and all the rest of the cloak-and-dagger agents are elucidated. Another *tour de force*.

The following four chapters deal with the evaluation of foods under the headings of digestibility; the partition within the animal of food energy; systems of expressing the energy value of foods; and finally, protein evaluation. It is here that the authors achieve the distinction of being the first to include, in a text-book written for students, the views of Blaxter. That bright star had been shining in the west of Scotland for some years and naturally had attracted the attention of the Three Wise Men in the East. Two more chapters discuss feeding standards for maintenance, growth, reproduction and lactation; and the final seven chapters deal with the main features of

home-grown and imported feedingstuffs, finishing with a discussion on the use of growth stimulants. Each chapter is provided with well-chosen bibliography for further reading.

The Appendix contains tables which are very intelligently constructed. Separate ones are provided for the foods of ruminants, pigs and poultry. Not only is starch equivalent given but also metabolizable energy in k cal/lb. Similarly, total digestible nutrients are paired with digestible energy and, for poultry, digestible carbohydrate is listed with metabolizable energy. Other tables give amino acids, minerals and vitamins. Finally, there are tables of feeding standards for the various classes of farm livestock.

The mean-souled reviewer pretends to bow before his god, but all the while his sly eyes are slithering over the ground to find a boulder to smash the feet of clay and bring the idol toppling down. He finds little satisfaction here. There are no feet of clay. The book is firmly based on unassailable knowledge, and only a few tiny pebbles are to hand. In all the 400 pages only two unimportant misprints were observed (a tribute to printers and authors alike): a mispelling of dehydrogenase, and the omission of the 1 from $1\frac{3}{4}$. The correct figure is given in Table 14.5 on the following page. Perhaps some would consider that 3 to 5 ppm molybdenum is high for 'normal' pasture; that supplementary copper is better injected as a chelate than given by mouth as sulphate; that some milk taints arising from food do so via the udder and not from the atmosphere (e.g., when large quantities of kale have been strip-grazed shortly before milking time); that wilting to a dry matter of 30–50 is only possible in favoured areas, and that even a modest 25–26 is worth having. Obviously these are trivia and this merely serves to underline the excellence of the book. Only one slack phrase was noted. In a reference to vitamin E it is said that '. . . the evidence suggests that (deficiency of) the vitamin does not play any appreciable role as a cause of infertility in cattle . . .' Omission of the words in brackets completely reverses the intention of the writer.

This book is the best gift ever offered to the student of agriculture who wishes to grasp both theoretical and practical aspects of the nutrition of farm animals. May it see many editions! It comes at just the right time because nutritional science is in a ferment at present with the publication of the A.R.C. recommendations on the nutritional requirements of farm livestock.

S.M.B.

Woodlands. (Modern Biology Series). J. D. OVINGTON. English Universities Press, 1966. 21*s*.

Here is a comprehensive and readable review of the world's forests as they appear to a leading biologist. It will serve as an introduction to their purely scientific side for forestry students and teachers of woodland ecology for years to come. The many fine pictures show the marvellous range of tree communities around the globe, from spruce and birch woods of northern Sweden to the tropical rain forests of Nigeria. Professor Ovington's agile mind takes the reader through every field of pure science that has a bearing on the living tree—how it uses the soil but restores nutrients to it through leaf-fall; what birds, beasts and insects find their homes in its foliage; and how it uses the energy of the sun, just as a farm crop does, to build up its substance.

Surprisingly, scarcely anything is said about the harvesting or uses of timber. Paper pulp, which absorbs 40 per cent of the woodland output in Canada and Scandinavia, and a growing proportion of that in Britain, gets no mention at all. The main reason why people grow trees, and on occasion claim some of the farmer's poorer land for doing so, is that woods produce what the community wants—fencing, building material, and packaging to get the world's food from the fields to the markets. Forestry is an economic activity, not just a fascinating branch of nature study.

Although the author displays photos of plantations in countries as far apart as England, New Zealand, Kenya and Japan, it is clear that he has little sympathy for the business of raising trees artificially in nurseries and planting them out to form timber-producing stands or windbreaks. Diagrams show the farmer how to manage his coppice-with-standards woods—now admitted to be unprofitable everywhere, or pure coppice—profitable only for sweet chestnut in Kent. But no clue is given as to the everyday work of establishing and tending the trees that a modern farmer is likely to raise for timber or shelter, or to make better use of a patch of rough land. The only time the power saw is mentioned, we are told it may scare away tourists!

It is a good book, then, for the theorist, who wants to follow the nutrient cycle through woodland plants, worms and soils, or to know how forests may help to control erosion, conserve water supplies, or attract tourists; but hardly a guide for the practical timber grower.

H.L.E.

Pesticides in the Environment and their Effects on Wildlife. *Journal of Applied Ecology*, June, 1966. Vol. 3, Supplement pp. 1-311. Edited by N. W. MOORE. Blackwell Scientific Publications, 1966. 70*s*.

Readers of *Agriculture* may be surprised to learn of the existence of an 'Institute' sponsored by NATO for dealing with pesticides in the environment and their effects on wildlife. The explanation is that Dr. N. W. Moore, of the Nature Conservancy, is secretary of the IUCN's Committee on the Ecological Effects of Chemical Controls; that in this capacity he approached NATO for help for the international side of the Committee's work; and that NATO responded 'quickly and generously by offering to sponsor an Advanced Study Institute on Pesticides in the Environment and their Effects on Wildlife'. The symposium lasted a fortnight and was attended by some seventy biologists, toxicologists and chemists from a dozen different NATO countries.

Thirty-four papers were read and discussed and the editing of these was done for the *Journal of Applied Ecology* by Dr. Moore and his wife, Mrs. Janet Moore. Dr. Moore was also Chairman of the Institute and contributes a final paper in which he assesses the discussions.

The resultant volume of over 300 pages is an excellent compilation and each paper has not only a summary in English but also summaries in both French and German. There are two papers by representatives of the Ministry of Agriculture, Fisheries and Food; the first, by Strickland, gives estimates of insecticide and fungicide usage in England and Wales and one, near the end, by Turtle discusses assessing the risks to wildlife from new pesticides under the Pesticides Safety Precautions Scheme. Strickland estimates that 'insecticide use pays for itself in cash terms ten or twelve times over', but most of the papers in this volume are concerned with a more intangible factor, namely, the price that may have to be paid in the effect on wildlife of environmental contamination. The symposium throughout dealt almost entirely with the persistent organochlorine insecticides; four papers show how widely these insecticides have become distributed in the environment far from their area of application; a number of papers describe the complex effect pesticides have on aquatic ecosystems and lay emphasis on the solubility of pesticides in fat and their subsequent accumulation in food chains; some half dozen papers are concerned with the toxicological effects on birds, fish and marine molluscs; six papers describe work on birds, especially on raptors; and there is one on mammals.

Two papers that possibly describe what may eventually prove to be the most far-reaching effects of persistent pesticides are those by Olive B. Cope and Warner, Peterson and Borgman on, respectively, contamination of freshwater ecosystems and the effect on the behaviour of fish of sublethal doses of pesticides. The conclusions from the latter state that the 'findings vigorously support the hypothesis that pesticides and other water contaminants may have profound effects on aquatic life at concentration levels far below those producing death or immobility. They also challenge the naïveté of the prevalent philosophy which assumes that until harmful sublethal effects of a compound can be demonstrated, none exist. On the contrary, our position is quite clear. Until the biological effects of a compound known to have some toxic properties have been established through adequate research, that compound must be assumed to be potentially dangerous'.

Anyone who is still sceptical about the harmful effects upon animal reproduction and behaviour of sublethal doses of pesticides should critically examine his opinions in the light of these two papers.

In an appendix, there is a general statement by the participants in which a number of recommendations are made, the emphasis being on the need for more work including further routine collection of data, more experimental research, more use of present knowledge and better dissemination of knowledge.

I.T.

Estate Villages. M. A. HAVINDEN. Lund Humphries, 1966. 50*s*.

Few communities have changed so drastically in the last generation as the village. Few are likely to change more drastically in the years to come. A manner of life, a form of society with a continuous history of over a thousand years, is vanishing before our eyes. It is fortunate, therefore, that the Museum of English Rural Life has been able to sponsor this detailed study of the past and present development of the two Berkshire parishes of Ardington and Lockinge before the new age has too finally re-created them.

The first chapter of the book gives the geographical and historical background of the villages. But the real story starts with

the establishment of the Lockinge Estate in mid-Victorian times. One of the first acts of the new owner set the general tone of the future. Part of one village was destroyed and the villagers rehoused in model cottages on a site which allowed the manor-house more privacy.

Purposeful, humane landlordism is the author's major theme. Enterprising landlordism, too, for in the depression of the later nineteenth century Lord Wantage became one of the few owners to beat the slump by means of large-scale farming. So to the second theme, the development of a farming empire which at one time totalled 10,000 acres and is still over 4,000 acres. The chapters on the managerial structure and policy of this huge and successful enterprise give one of the best accounts of this type of farming now available.

Mr. Havinden has made a gallant effort to maintain his third theme, the changes in village society in the last hundred years. But here he has been less successful. He has collected his evidence diligently. Occupational and residential statistics, including a telling age-group table on page 177, the memories of elderly villagers, emigration, church and chapel, living standards, the size of families, education, the mummers, the W.I., the advantages and disadvantages of living in the rural equivalent of a 'company town'—all are there. So are some shrewd comments, such as the reference on page 198 to the different expectations of young and old. But there are also some surprising omissions, notably on reading habits, car-ownership and holidays. And the information fails to form a coherent story. It remains interesting raw material. Indeed, this book is not really a history of village society but the story of an estate to which is added a study of two villages, mainly as seen through the windows of the estate-office. We are some way from Gosforth and Ashworthy, and further still from Lark Rise and Candleford.

The book is well-written, well-produced and well-illustrated. Mr. Loughborough's maps deserve special praise.

N.H.

Men of Lakeland. W. R. MITCHELL. J. M. Dent and Sons, 1966. 30*s*.

Books on the Lake District seem to be produced in a never-ending stream. This, it has to be accepted, is the inevitable consequence of the powerful attraction which the area holds for thousands of summer tourists. But, praise be, this book is in a class of its own; it is as outstanding for its treatment in depth as it is for its delectable writing. Here there are no superficialities; Mr. Mitchell's three ingredients are the land, the men and the sheep. He shows vividly their interdependence and their integration, the environmental influence over centuries on native character, the hazards to men, sheep and dogs of weather, terrain and wild predators, and the unsophisticated pleasures which occasionally break the common round.

Farming the fells has from time immemorial meant Herdwicks, that spirited, tough breed of sheep whose origin, like so many other things romantically ascribed to salvage from wrecked Spanish galleons, is still uncertain. It is known that the Cistercian monks of Furness ran such (unimproved) sheep thickly on their large estates; and indeed a 'herdwyck' was their name for a sheep farm. But without the hard-working, agile fell collie, this austere lean area would for all practical purposes be completely lost to farming.

The author takes his readers from fell to dale, from dale to fell, as season follows season and the management of the flocks requires, and he does it with close knowledge and meticulous observation of the skills and sweating labour involved. Equally in this, John Peel's country, he knows the pace and pursuit of fox-hunting on the fells 'when mist swirls down to blot out the rough countryside and the huntsman has only his ears to guide him as to the progress of the hunt'. Nor has he neglected to include a chapter on that age-old, democratic sport of wrestling (takking hod), which can be seen at any daleshead sports meeting during the summer; nor to savour in retrospect the Merry Neets which are the valediction to the dying year.

This is a worthy picture of the Cumbrian dalesmen and their daily lives, largely unseen by transitory visitors, and we are Mr. Mitchell's debtors for having given it to us.

S.R.O'H.

Books Received

Farm Business Statistics for South-East England. Supplement for 1966. Copies from the Secretary, Department of Agricultural Economics, Wye College, Ashford, Kent, price 4*s*. (including postage).

Meteorological Office Annual Report 1965. H.M.S.O., 1966. 9*s*. (by post 9*s*. 7*d*.).

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G. and S. G. Neal Ltd. have changed their telephone number to Holbeach 2606-7.

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